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ABSTRACT

This document contains lessons designed for teaching geography and map skills to intermediate level students, although many may be adapted to other grade levels. The lessons place heavy reliance on children making a series of individual and collective maps. The 16 lessons included are: (1) mental maps; (2) conventional maps; (3) map elements; (4) map evaluation; (5) map symbols; (6) orientation; (7) making a photomap; (8) community map; (9) making a turf map; (10) using map grids; (11) map scale; (12) making a map scale; (13) map-reading review; (14) using the grid; (15) making outline maps; and (16) special purpose maps. Thirty-six figures appear throughout the guide, and a 31-item reference list is included. Three appendixes refer to sources of specialized maps. (DB)

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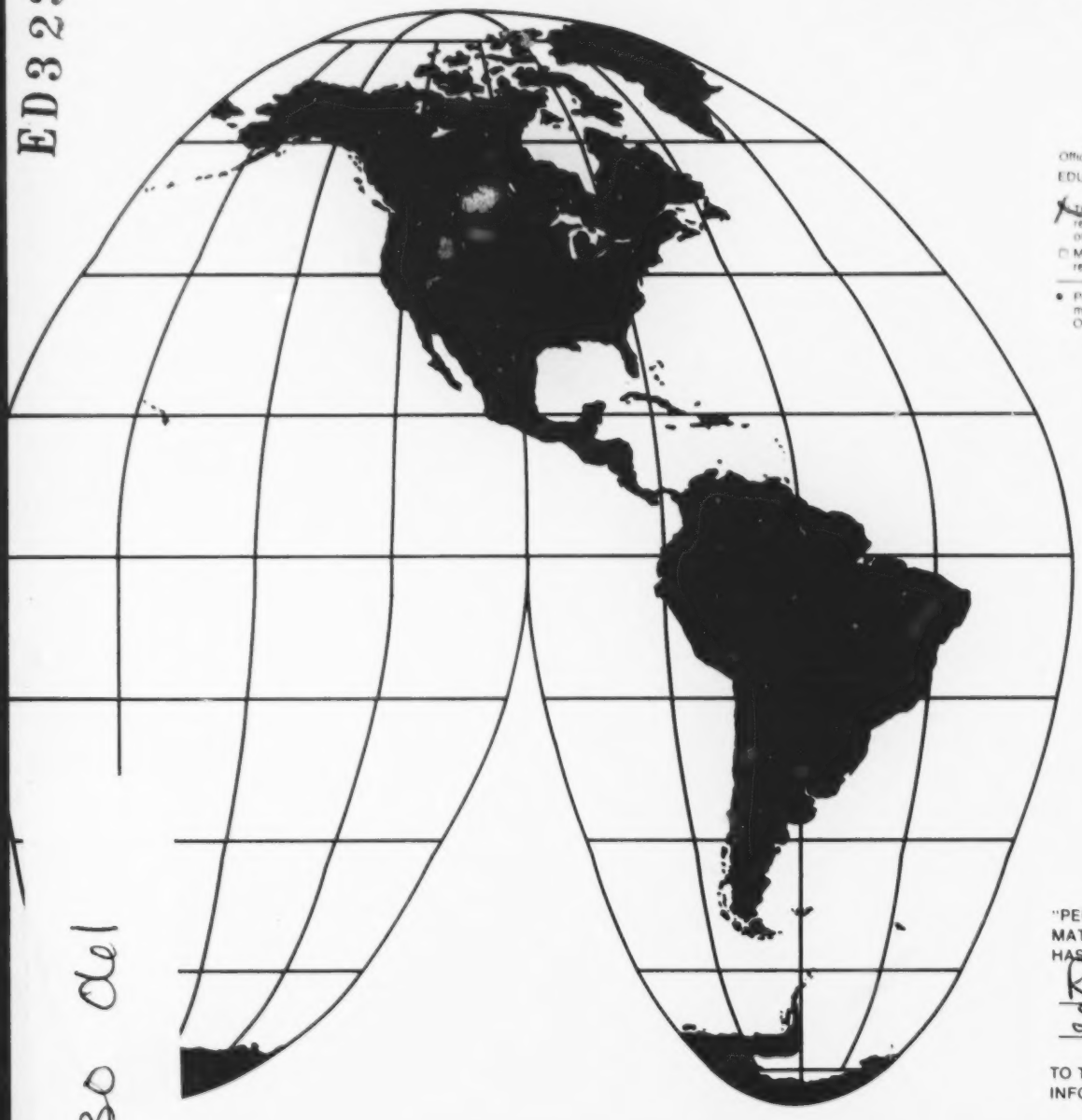
TOPICS IN GEOGRAPHY, NO. 8

TEACHING MAP SKILLS: AN INDUCTIVE APPROACH

JEREMY ANDERSON



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TEACHING MAP SKILLS: AN INDUCTIVE APPROACH

JEREMY ANDERSON

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Teaching Map Skills: An Inductive Approach

Part One

Since discovering some fifteen years ago the great potential "turf maps" have for revealing the latent geographer who dwells in us all, I have developed an array of lessons to teach geography and map skills to students ranging from third grade through college. On sabbatical leave between 1978 and 1979, I created and taught a two week map skills unit to several fourth and fifth grade (9-10 year olds) classes in the Raleigh-Wake County, North Carolina public school system, in exchange for the opportunity to do research on the outdoor play behavior of the students. These lessons placed heavy reliance on children making a series of individual and collective maps. Subsequently, these lessons were refined and elaborated upon in a number of classes and workshops.

Although the lessons were developed for and taught primarily to intermediate level students, teachers can adapt many of them to other grade levels. As a rough guide, the complete unit takes about four to five weeks.

My inspiration comes in part from Jean Piaget who wrote the book *To Invent is to Understand* (Piaget 1973). My own cognitive style is that I am a slow reader, graphically and empirically oriented, highly reliant on the right-side of my brain, and learn best by doing and inductive methods. These considerations and twelve assumptions that follow guide the design of the lesson plans and their sequence. The assumptions are: (1) Map-making and map-reading are fundamental skills with great survival and learning value; (2) Map skills can be used to enhance learning in all areas of the curriculum: science, social studies, mathematics, reading, communication skills, civics, physical education; (3) Children who learn how to make maps will be more able and willing to use maps as learning aids; (4) Map-making and map-use instruction should proceed from local to global, large scale to small scale, and from the child's immediate and concrete experiences to abstract concepts and levels; (5) Using a dialectical process of learning theory and concept, and then applying these theories and concepts to map-making or map-use projects as soon as possible, will increase student understanding and mastery; (6) Students should discover concepts and principles for themselves by means of Socratic questioning, inquiry, and inductive reasoning; (7) Students should be constantly surrounded by maps pertinent to their studies and personal interests. A corollary is that map examples used in lessons and exercises should be "real world" products or problems to as great a degree as possible; (8) Like any skill, opportunities for continual practice will greatly enhance students' level of mastery, understanding, and confidence in the use of maps. Some repetition and drill in map-making and use is desirable, and need not be tedious or boring; (9) Once mastered, map-making and map-use are not difficult, and students with limited verbal and mathematical skills may excel in certain aspects of map skills; (10) All lessons and exercises should first be done by teachers so that any difficulties and pitfalls may be anticipated and modifications can be made for particular student needs; (11) Many of the map skill lessons are enhanced in value when done by students working in teams, and the value of cooperative work may also be learned; (12) If teachers get "hooked on maps," it will be contagious, and many of your students and coworkers will also get hooked and help to build a good map collection for teaching.

The logic or rationale for the organization of the unit follows: Lessons One and Two introduce students to the nature of maps, the variety of ways that maps can exist in our minds, the variety of maps that people make, and what sets maps apart from other graphic representations of real or imaginary places. Lessons Three and Four focus on specific map elements or conventions that cartographers employ to aid map readers in understanding and using maps most effectively. Lessons Five and Six deal with two fundamental elements, symbols and orientation, in some detail. Because students need a good conceptual

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background to become successful cartographic communicators, more than a week is devoted to introducing and talking about maps. Students are given only one opportunity to make a rudimentary sketch map (in Lesson One). Lessons Seven, Eight, and Nine give students lots of experience in map-making and opportunities to apply skills learned in previous lessons when they make, in quick succession, a "photomap," a community resource map, and a neighborhood "turf map."

The "photomap" and community resource map are compiled by teams of students using aerial photographs and base maps prepared by professional cartographers. These exercises give students a good idea of how maps are compiled and made, as well as ample practice in employing previously learned elements and symbols. Students, therefore, have a solid grounding in the nature of maps by the time they are asked to draw a sketch map of their own neighborhood emphasizing the play areas of greatest importance to them.

Students learn about map scale and map measurement in Lesson Ten, and apply this information to the making of a large-scale map in Lesson Eleven. Lessons Twelve through Fourteen focus on smaller scale maps of larger portions of the world, and students learn about the use of map grid systems and map projections. In these lessons, they practice the reading and interpretation of such maps. Lessons Fifteen and Sixteen give students the opportunity to learn how to compile their own outline base map and to make a variety of special purpose (topical or thematic) maps.

Supplies and Equipment

There is no such thing as a "free" map. All maps require effort to make, acquire, and keep. In order to teach map skills effectively, you will need a number of items. Working with a severely limited budget, I have made every attempt to find the lowest cost materials possible. Not all of these materials are needed at every grade level, and some might best be centrally located in the school media center (i.e., magnetic compasses, outline map masters, wall and flat map collections). The list that follows is neither minimal nor ultimate, just highly recommended.

(1) Acquire a generous supply of good and bad map examples for illustration, decoration, and class assignments in map analysis and use. These maps need not be obtained all at once, but your collection will grow as you use maps more frequently in the classroom. Students can bring maps from home, and you can find lots of examples in newspapers and magazines, on restaurant placemats, in promotional literature, and in school texts and library books. You may wish to consult several good general guides to map sources (Greenhood 1964; High School Geography Project 1970; Muehrcke 1978).

(2) Obtain lots of plain white paper for map-making projects. The paper should be sturdy enough to stand erasure, big enough to accommodate large images—a fifteen to twenty inch (forty to fifty centimeter) wide roll of butcher paper is ideal. Get some tracing paper for making special maps compiled from information found on other maps; high quality kinds are often carried by college bookstores and by engineering or art supply shops. Once you find good sources of supply, let the proprietors know your needs and budget restraints, and they may help you out by finding inexpensive rolls or remainders. Procure some cardboard, which is most useful for creating three-dimensional maps and models, for mounting large maps when there is a lack of bulletin board space and for making inexpensive clipboards. Big sheets are available from cartons at business equipment, furniture, and appliance stores. Use a carpenter's knife and yardstick to cut cardboard with ease.

(3) Obtain three kinds of measuring devices. Provide every student with a six to twelve inch (fifteen to thirty centimeter) ruler with metric scale on one edge and English scale on the other for desk work assignments. You will need two or more yard or meter sticks and one or more six to twelve foot (two to four meter) measuring tapes for assignments that require larger measurements.

(4) Assemble an appropriate set of outline maps (e.g., community, county, state or province, large subregions of your country, the country as a whole, continents, world), depending on areas studied and specific curriculum needs and objectives. Local college bookstores or geography departments are usually good places to start such a collection.

(5) Three items seem minor, but they are necessary for effective map-making and map-use. Get a good supply of masking tape and large straight pins for temporary and longer term hanging of maps. Beware that masking tape destroys the surface of most maps, but it is useful for hanging up large butcher paper maps made by students. Straight pins are excellent for posting maps on bulletin boards with a minimum of damage, are recyclable, and may be used for map symbols. Make or purchase a sandbox. Every good geography and earth science classroom from nursery school through college should have a sandbox. A small box about two to two and one-half feet (sixty to seventy centimeters) square with four to six inch (ten to fifteen centimeters) sides is sufficient together with a modest supply of fine sand, dirt or even salt, and a good selection of randomly sized blocks for environmental modeling and mapping play. A cardboard box, modeling clay, and cardboard squares of varying sizes is an acceptable substitute if you are afraid to risk the mess and miss the rewards of a sand or dirt box.

(6) Optional devices that will be useful from time to time are a magnetic compass to use for directional orientation in the classroom and outdoors; several drafting triangles or *T*-squares (even if cut from stiff cardboard) to permit students to draw right angles accurately and easily; a large chalk-holding pair of compasses for making circles on chalkboards and a number of smaller pencil-holding compasses for student use; and a sundial mounted in an appropriate (relatively shadow-free) place in the schoolyard, or several straight dowels or stakes for sun-shadow measuring experiments.

(7) The classroom should have plenty of bulletin board or wall space for displaying maps, especially those made by students. A continually changing display of student work is an excellent way of building self-esteem, community spirit, and parental confidence in the instructional program of the school.

(8) The assumption is made that classrooms are equipped with chalkboards, and that projection screens, overhead projectors, projector pens, and clear acetate sheets for drawing on projectors are readily available. The assumption is also made that a thermofax machine, thermofax transparency making material, and photocopy and ditto machines are available for making and reproducing instructional materials when needed. The length of this list is not intended to intimidate, but merely drive home my opening argument: there's no such thing as a free map. If resources are really scarce, much of the unit can be taught using pencil, paper, chalkboard, and textbook or other secondhand maps. Also, you may obtain some of these materials relatively cheaply at local flea markets and garage or thrift sales. Remember that the expense of any materials that you do buy without getting

reimbursement is tax deductible.

(9) Two books deserve special mention, and you should try to secure copies of them for your school teachers' reference library, if not your own collection. The best one, unfortunately out of print, is by one of my heroes, Erwin Raisz, a man who loved and lived maps, and wrote lovingly about them (Raisz 1962). If you are lucky, you may find a copy at a good used or secondhand bookstore. Raisz is famous for his physiographic maps and oblique perspective sketch maps; all his maps are lettered by hand, and most of his figures were designed and drawn to illustrate specific points in his text. The other book, also lovingly written, is by David Greenhood (1964) and is available as a paperback.

Lesson One: Mental Maps

This lesson introduces students to the fundamental notion that we all have a great store of geographical images in our brains that may be called upon to aid us in dealing with our environment. The lesson should enable students to tell in their own words what a mental map is, to give several examples of mental maps, and to tell how they are used in everyday behavior. The lesson should take about one class period or about forty-five minutes. It requires some plain white paper for students to make sketch maps.

Start the classroom discussion with the following questions: Did any of you bring maps to school with you today? How did you get to school? To the bus stop? If you were blindfolded or blind, could you find your way from your desk to the classroom door? (At this juncture you, the teacher, should shut your eyes tightly and demonstrate your own mental map of the classroom by feeling your way to the door and naming the objects that you anticipate encountering on the basis of your mental map.) Can you shut your eyes and imagine that you are a bird flying high over your neighborhood? Can you tell what your house or apartment and the area around it looks like from the viewpoint of a bird?

Given these questions, students usually become aware that each of us has a head full of maps. Our mental images are unlikely to be in the form of published or drawn maps, but they are our knowledge of where things are located in places familiar to us—in our houses, neighborhoods, city, region, and country. This knowledge constitutes basic information that we can use in our everyday activities, and that we can map.

Focus subsequent discussion on the diversity and uses of mental maps (Figure 1). Remember, mental maps may be expressed verbally as pictures, sketch maps, in three dimensional forms using ordinary objects as symbols (Figure 2), and through movement in space (i.e., the blind search for the classroom door demonstrated during the introductory questioning session). Virtually any kind of

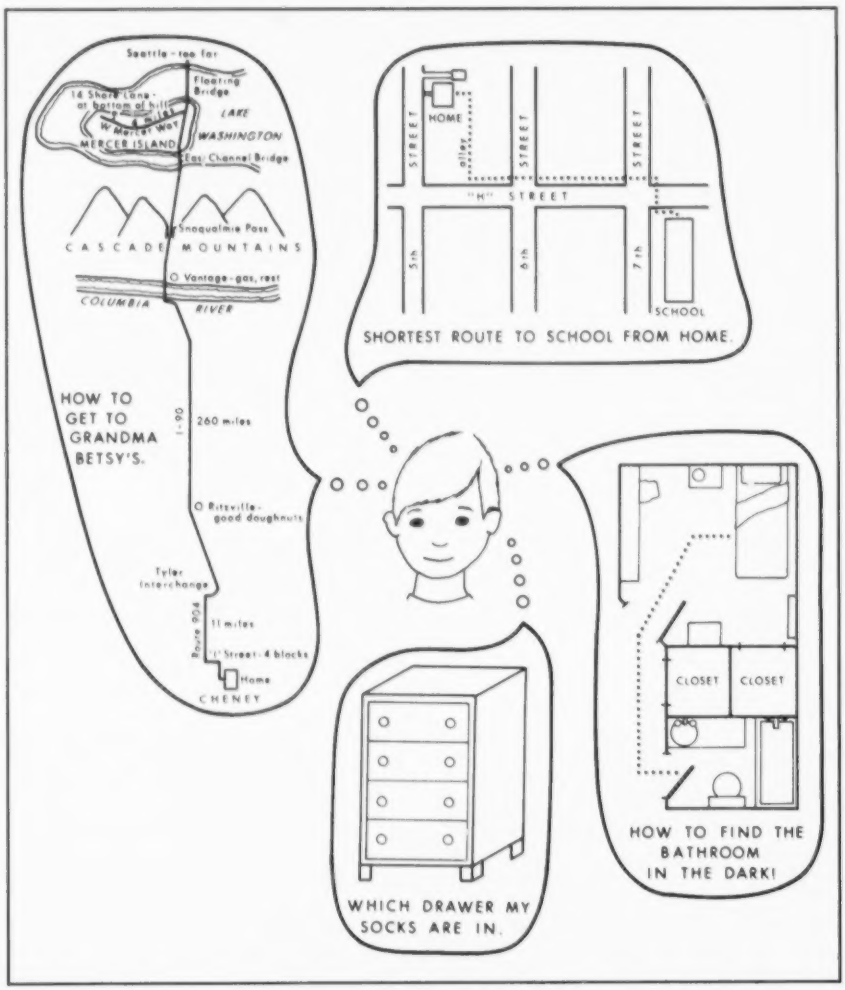

Figure 1. Our heads are full of "mental maps." Source: Author.

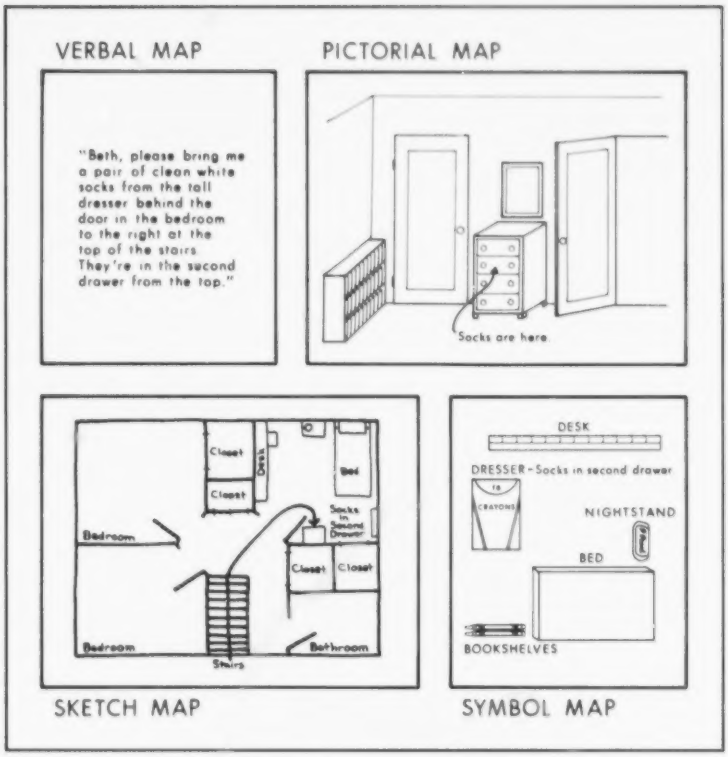

Figure 2. Four different ways to "map" the location of Jay's socks. Source: Author.

image (e.g., picture, aerial photograph, model, or verbal description) that permits a person to visualize where things are located or what a place is like is a map.

One demonstration of such map imagery follows. Twenty students, by using themselves, can make a simple population map of the world. Each student represents about 250 million people, or approximately one-twentieth of the current world population of 4.75 billion. One student represents the total population of North America (US and Canada), two students represent Latin America, two students Africa, three students Europe including the USSR, and the remaining twelve students represent Asia. This exercise illustrates the use of symbols and dramatizes the global distribution of population.

End the lesson by asking students to make a sketch map that shows their "mental" image of how one of their favorite rooms or play areas looks from a "bird's eye" perspective, or to make a sketch map that shows how they get from home to school or to some other important place. Students should keep these maps to use in Lessons Three and Four. As a homework assignment, tell students to find and bring to school any maps from home that they may find in discarded newspapers or magazines or old road maps that their parents no longer need. These maps can be used in the next lesson.

Lesson Two: Introducing Conventional Maps

The mental maps discussed in Lesson One introduce an element of ambiguity into the common stereotype of what constitutes a map. This lesson challenges students to resolve this ambiguity by comparing conventional maps to other images that may be construed as valid mental maps. At the conclusion of the lesson, students should be able to define a "conventional map" in their own words, give several examples of such maps, and say something about their uses. Materials needed for the lesson are (1) a conventional picture of a building or some landscape or object familiar to the class; (2) an aerial photograph (Appendix A gives sources for these); (3) an early or primitive map (Appendix B); and (4) several examples of conventional maps.

Begin this lesson by telling students, When we talked about mental maps, we noted that almost any kind of image—words, pictures, photographs, or bird's eye views—can be used like maps to find our way, locate some place or thing, and describe or learn what some place is like. Today we are going to discuss what conventional maps are like and how they differ from other kinds of images. And from now on, when we talk about "maps," we'll be referring to what we usually call maps—the kind we use for travelling to different places, or those we find in atlases, books, newspapers, and magazines.

Follow up these introductory comments with a brainstorming session in which students state what they understand the noun "map" to mean. Ask students to explain how maps differ from other kinds of images. Accept all student definitions and ideas, and list them in summary form on the chalkboard, newsprint pad, or overhead transparency. Discuss these definitions and ideas to eliminate redundancy and inconsistencies and, perhaps, to narrow the definitions to where there appears to be some consensus. Closure, however, need not be attained at this time.

Next, hold up a conventional picture (Figure 3) and discuss whether or not it fits the definitions arrived at in the preceding discussion. Tell students to defend their positions both for and against its being a "map." Discuss their positions before offering statements of resolution or definition. (A conventional map is a special kind of picture, a view of a place as seen from above. Most

Figure 3. Is this a "map"? For whom or under what conditions might it be considered one? Source: Author.

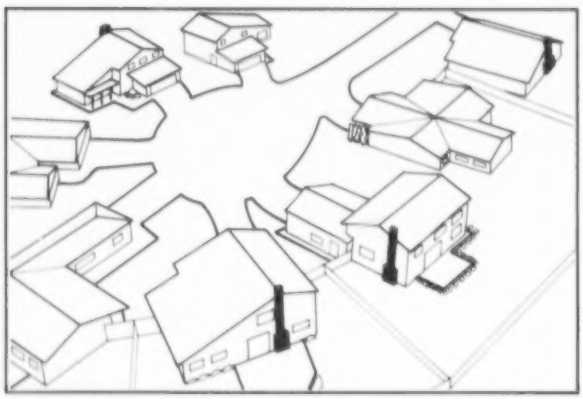

Figure 4. Is this a "map"? What things could you add to it to make it more "map-like"? Source: Author.

pictures, therefore, are not maps, because they are usually views of things or places as seen from the ground or the side rather than from above, a horizontal rather than a vertical perspective.)

Use the same teaching method for an aerial photograph or Figure 4. Encourage students to discuss the pros and cons of their arguments. (Aerial photographs, like maps, are pictures of places or things as seen from a vertical perspective but cannot easily be used as maps. They show lots of detail, but if you know nothing about the place shown or nothing about how to use aerial photographs, you will have a hard time telling where the place is or identifying many of its distinctive features. Maps generally use symbols and written words to show only the features the map maker wishes to show—streets or highways, important buildings or towns, larger bodies of water, hills, mountains. Maps may also provide information about places not always obtainable from aerial photographs—place names, languages spoken, climates, soils, and species of plants or animals present. Maps are also generalized models of reality; they often omit elements that can be seen on aerial photographs—individual buildings, trees, cars or other machines, people, and animals.)

Follow the same approach using an early map example (Figures 5 or 6). (Early maps are full of symbols whose meaning may be readily deduced. The symbols say something about the location or arrangement on the earth's surface of features that were important either to the map makers or to the persons for whom the maps were made.) I use a portable sandbox and a stick to draw a primitive map for students, and they can see for themselves how some of the earliest maps may have been drawn and used.

Ask students to share and discuss examples of maps they brought from home. The diversity of maps available may be illustrated using a reference atlas or, better still, using a bulletin board display of the students' and teachers' map collections. This lesson may be concluded by asking students to define "map" one more time. My simple definition is: a generalized, bird's eye view picture that uses symbols to show where things are located within, or some characteristics of, some real or imaginary place. A most useful discussion of the definition of map is found in *Principles of Cartography* (Raisz 1962, pp. 30-38).

Lesson Three: Map Elements

Nine peripheral map elements are important aids for helping map readers get the most information from maps. Experienced map users take them for granted; many geographers and cartographers, who should know better, fail to include them when designing maps for publication. At the conclusion of this lesson, students should be able to list, define, describe, and give an example of each of these nine elements: title, orientation, author, date of drawing, legend or key, scale, grid, index, and source of information.

For this lesson, you will need the student sketch maps made in Lesson One, or a large-scale aerial photograph of a part of the class' home town or area, or any map lacking all or most of the nine elements. For example, many textbook maps lack some of these important peripheral elements. You will also need an official state highway map. Most state highway or transportation offices publish highway maps, and they may give you several copies of a map for class use.

Focus the lesson on the nine peripheral elements that, if added to a map or aerial photograph, would help map readers understand it more easily or make it more

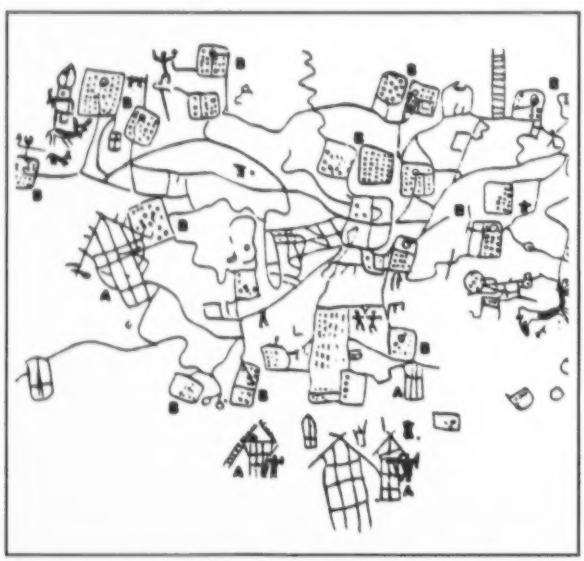

Figure 5. One of the oldest known maps shows a neolithic village in Italy around 5000 B.C. See if you can determine the meaning of the various symbols used by the map maker. Source: Lugli (1967).

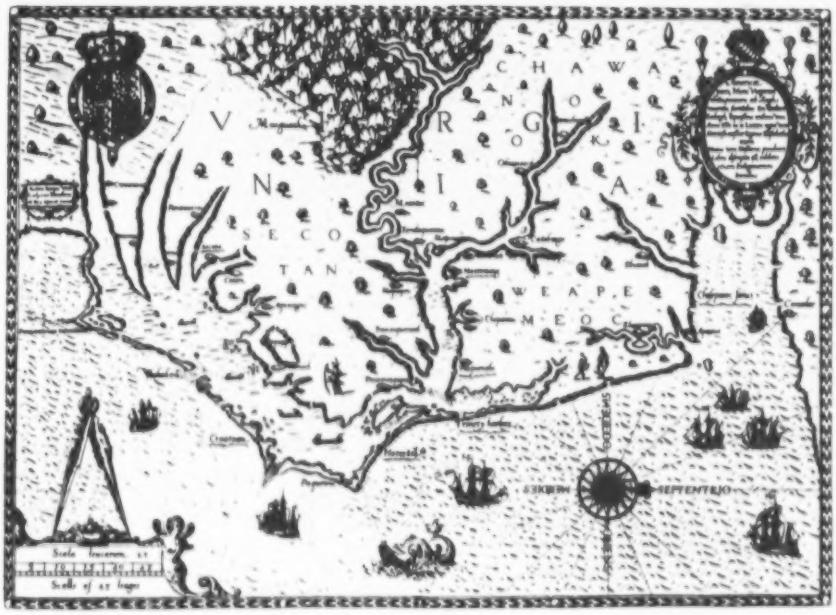

Figure 6. One of the first maps of Virginia, published in 1590. Source: Cummings (1962, plate 14).

"map-like." Post map examples in prominent places where students may study and compare them. Make several examples into overhead transparencies using thermofax materials in order to focus class discussion.

Start this lesson by writing, "Every sketch map should have a *TOAD*!" on the chalkboard. Underneath add "Most maps need *TOADS* or *TODALS*, and some maps need *s* or *IGs*!" Then after writing out the complete acronym *TODALSIGs*, ask students to see if they can determine what map element each letter of the acronym means. Explain to them that acronyms are words formed by the initial letters of ordinary words and are often used to help us remember a list of important things. Take one letter at a time, accept all student responses on the chalkboard, and then narrow the list down to the correct choice by means of a discussion. At this point, have a sample map transparency or aerial photograph projected or displayed so that you can test student suggestions on the map. Remember that map "element" refers to a significant peripheral component that most maps are supposed to have as an aid to helping map readers understand or use the map more effectively; an "element" does not refer to objects that may be mapped (i.e., *T* does not stand for tree or telephone pole). After a brief discussion of each letter, tell students something about each element as follows. Strongly encourage students to take notes.

T = Title: A good title describes what a map shows, where the place or area is, and often the time period portrayed by the map (e.g., Jeremy's Usual Bike Route from Home to Wiley School, Raleigh, NC, 1978-1979; Superbowl Locations, USA, 1965-1984).

O = Orientation: This word, which is derived from the Latin word *oriens* meaning sunrise or east, refers to the principal geographic directions on the map (*N* and sometimes *E, S,* and *W*) by means of an arrow or compass rose. General or geographical orientation may not be necessary if the map includes a geographical grid, or if the area's shape is so familiar that its orientation is readily recognized by map users (i.e., one's own state, province, or country, and most continents). Sometimes, local or relative orientation may be equally important: which way (and how far) is town, or downtown or school or grandmother's house from the neighborhood or area shown on the map? (Figure 7).

A = Author: Who made the map (e.g., Rand McNally, US Geological Survey, Meriweather Lewis, Mercator)? Knowing who made the map helps people to evaluate its reliability and tells them whom to contact if they discover errors on the map.

D = Date: When the map was made (e.g., about 2500 B.C., ca. 145 AD, 1569, 1/24/84). This information helps users to judge the relative accuracy of the map. How long ago was it made? How long was it made after the time period shown by its title?

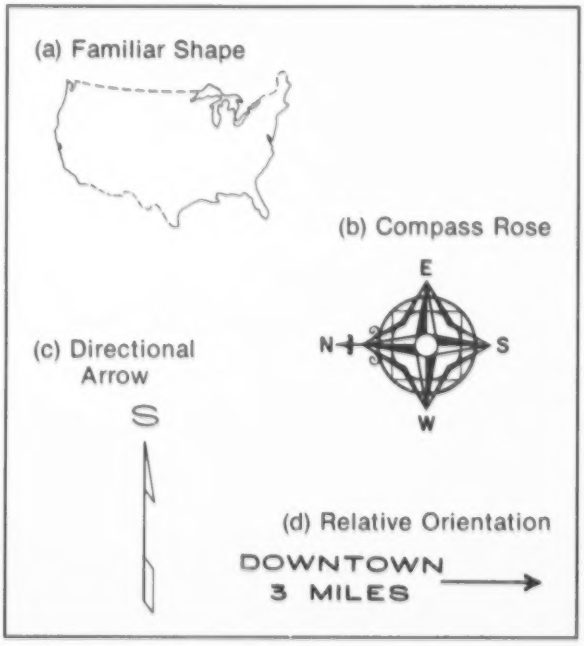

Figure 7. Four ways to show map orientation. Source: Author.

L = Legend (or Key): A legend shows the meaning of symbols used on a map whose meaning is not absolutely clear or which are not labeled on the maps. Map symbols are not always self-explanatory because they may be interpreted to mean several things (i.e., $ = store or bank; = = = = = = = = dirt bike trail or rough road; //// = parking lot or steep slope).

S = Scale: What distance does a unit of measure (i.e., inches or centimeters) represent in the area actually shown on the map (i.e., miles or kilometers)? Scale may be expressed verbally, as a ratio, or in graphic form (Figure 8).

G = Grid: A grid is a set of intersecting lines that provides a "map address" or a way of describing the location of particular places on a map. Two kinds of grid systems are commonly used: (1) A simple arbitrary system is often used on city street maps or state highway maps; (2) A geographical grid system is often used in atlases and on other maps showing large areas of the world. The geographical grid system is also useful for orienting maps (Figure 9).

I = Index: The index is an alphabetical list of places shown on a given gridded map or set of maps that also gives the grid address of each place listed (i.e., Raleigh: H-3; Cheney, WA: 47.29 N 117.34 W).

s = Source: The source of map information not obtained from the direct experience or observation of the map maker (i.e., Map compiled from Raleigh East 7.5-minute Topographic Quadrangle, US Geological Survey, 1973, and information provided by Mrs. Johnson's fifth grade class, Bugg School, March 1979; or US Statistical Abstract: 1984, [Washington, DC, Government Printing Office, 1985]).

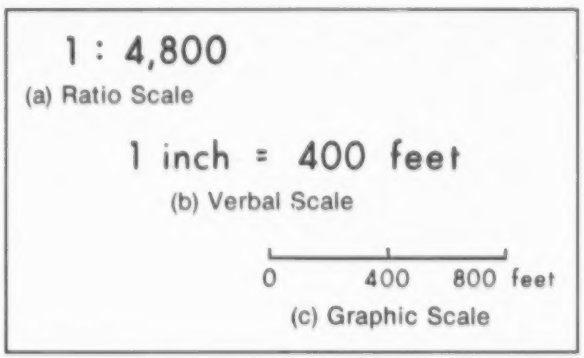

Figure 8. Three ways to show map scale. Source: Author.

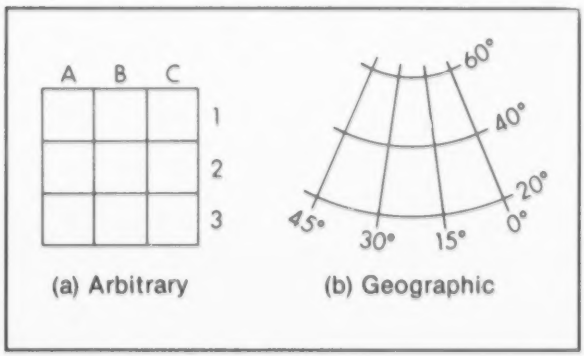

Figure 9. Two kinds of map grids. Source: Author.

After correctly guessing each map element represented by the letters in the acronym, ask students to define that element and then discuss why that element might be important to put on a map. Emphasize that not all maps need all nine elements, and discuss under what circumstances each element would or would not be appropriate. Useful discussions of the most common of these elements are found in a book by Erwin Raisz (1962) and in an article by Susan Nelson (1980).

A title helps users to know what the map is supposed to show. Orientation helps users to know what direction things are from each other on the map (i.e., is downtown east or west of Pullen Park?). Author and date are valuable pieces of information that are often omitted from maps. It is possible to assume, however, that textbook or atlas maps were all authored by one of the persons or organizations responsible for producing the work and that their content usually dates from a few months prior to the time of publication. The need for legends is apparent, but symbols on simple maps or maps with everything named or labeled directly on the map (i.e., Tarzan's Swinging Vine Tree) may be self-explanatory and, therefore, not need a legend. (The acid test is to show the map to people unfamiliar with it, and see if they can understand the map well enough to describe what it shows.) A scale is vital for maps drawn to scale because it allows users to measure distances and areas on the map (e.g., how far it is from Cheney to Spokane via I-90, or how many square miles (kilometers) are in our school attendance area?). Some maps, which show large areas of the world, can only show approximate scale because the scale may vary from one part of the map to another. The distortion is caused by the projection of the earth's spherical surface onto a flat page. Grids and indexes are needed only for maps that show large numbers of places (e.g., city street maps, state highway maps, or reference atlases). Sources of information like author, date, scale, and legend are often left off maps. They should be included whenever data is obtained from an identifiable source so that users may evaluate the quality of the data.

Teaching Map Skills: An Inductive Approach

Part Two

Lesson Four: Map Evaluation

This lesson gives students the opportunity to review and apply the concepts learned about map elements. Mastery should be demonstrated by the ability of students to correctly identify elements both present and absent from any map, and by their ability to evaluate whether or not a map would be improved by the addition of an element. They should also be able to correctly apply title, orientation, author, and date to the sketch map made for Lesson One. This lesson should teach students to critically evaluate their own and published maps. Every map should be viewed with the following questions in mind: (1) What is this map intended to show? (2) Does it have all the information it needs to serve its purpose? (3) Is it lacking some information or elements that should be included to help users understand it? (4) Does the map include unnecessary information or elements that clutter it up or detract from its intended purpose?

Materials needed for this lesson include student sketch maps made for Lesson One and several examples of well and poorly designed maps in terms of the inclusion and exclusion of needed map elements. Most official state highway or National Geographic Society maps are examples of well-designed maps with all or most essential elements present. Most science and social science textbooks in use in the schools are, unfortunately, full of examples of maps that are poorly designed and lacking in essential elements.

By way of introduction and review, first write the acronym *TODALSIGs* on the chalkboard and have the class briefly review what map element each letter stands for and the nature and significance of each element (Lesson Three & Figure 10). Direct the attention of students to an example of a good map. If possible, there should be enough maps so that there is one map for every two or three students. If maps are scarce, develop a worksheet that individual or small groups of students may fill in at a learning center. Ask students to find each of the nine elements, point them out on the map, and describe their location and appearance.

At this point in the lesson, start a discussion on the location of these elements on maps. Emphasize that, even though these elements are important aids for map users, most need not be large or conspicuous; in fact, they may actually detract from the usefulness of maps. Most of these elements are located at the corners of a map where room allows. Orientation, legend, scale, and grid are the only elements that are best placed within the "neatline" or border around the map proper; title, author, and date may be either inside or outside the border. Sources and indexes are usually placed outside the border. Normally, young students use the edge of the paper for a border, but they should be encouraged to observe the usefulness of borders as a map feature. Where unnecessary map elements are included, they too clutter and detract from the appearance and effectiveness of maps. Susan Nelson (1980) discussed many of these issues succinctly, although her map illustrations are poor examples.

T	=	Title	:	What, where, and when
O	=	Orientation	:	Directions
D	=	Date	:	When map was made
A	=	Author	:	Who made the map
L	=	Legend	:	What the symbols mean
S	=	Scale	:	What map distance is
I	=	Index	:	Map address of places
G	=	Grid	:	Locates places on a map
s	=	source	:	Of map information

Figure 10. Map elements summarized. Source: Author.

Next have students refer to one or two select maps in their text or to overhead transparencies of maps lacking several elements that should be present. Have the students discuss whether or not the usefulness or clarity of the map would be improved by the addition, alteration, or deletion of a particular element. Maps in books and journals frequently have no author and date, but this omission is not serious if the map author is also the publication author. The absence of clear titles (that tell what, where, and when), orientation, and scale are more serious omissions. Of course, the shape of familiar areas (i.e., one's own state, province, or country, and most continents) often provide adequate orientation, but unfamiliar or familiar areas shown from a nonstandard perspective (where north is not at the top of the map) should include orientation. Maps in texts that illustrate quantitative data frequently fail to indicate the time when data were gathered (i.e., for what year is the population or production distribution shown?). Textbook publishers often reuse twenty to thirty year old maps to cut costs and increase profits, and are reluctant to indicate how old their maps and data are. Maps that use quantitative information should generally show the source of their data as well. A map should have a legend when symbols are not conventional, clearly self-explanatory, or their meaning easily inferred from the title and context.

Finally, ask students to check the sketch maps they made for Lesson One. What elements did they include? Chances are that, because it was their first map, the only element students included was the author—their name. What elements did they leave off that should be included? All their maps should have a title, orientation, author, and date. If they used any unclear or unlabeled symbols, they may need to add a legend. Have students discuss which elements could not be included or are not necessary and why. Remember that sketch maps are not accurately scaled and, because they are based on the mental images of the students who made them, their authors are also the source of the data. These maps show small areas and do not need grids or indexes. Conclude the lesson by telling students to add a clear title (e.g., Jeremy's Backyard, 133 East Valley Street, Seattle, Fall 1941), local and geographical orientation, and the date their map was made.

Lesson Five: Map Symbols

In this lesson, students discover the nature and usefulness of symbols, especially as employed in the

design and making of maps. At the conclusion of the lesson, students should be able to define *symbol* in their own words, be able to correctly identify and point out examples of common map symbols on topographic, highway, and textbook maps, and critically evaluate symbols in terms of simplicity and clarity.

Materials needed for the lesson include (1) state highway maps (one copy for every two to three students); (2) USGS topographic maps of your local area, one at the largest available scale (either 1:24000, 7½ minute series, or 1:62500, 15 minute series), and one intermediate scale map (1:250000) (Appendix C). You should have at least one copy of each and preferably one for every three to four students; (3) a small, portable sandbox; (4) several toy houses, cars, trees, strips of colored paper for roads, sidewalks, lawns, and parking lots; (5) several photographs or pictures cut from used magazines showing common landscape objects (e.g., houses and other buildings, streets, highways, rivers, mountains, farms, fields, forests, factories); (6) an example of a "picture map" (Figure 11); and (7) USGS Topographic Map Symbol Sheet or Figure 12 (one copy for each pair of students).

Begin with a brief review of what a map is, and how it differs from aerial photographs and other kinds of pictures. Next tell students about the lesson's focus and then ask them to define the word "symbol." Accept and discuss all volunteered definitions in order to arrive at a satisfactory definition (i.e., a simple object, mark, or sign used to represent or stand for something more abstract or complex).

Invite students to provide some examples of commonly used symbols. You, the teacher, may wish to provide an example along the following lines: If one lets *s/* symbolize the word "symbolize," one could then write the following statements: letters *s/* sounds; pictures and words *s/* objects; *s/* symbolizes the word "symbolize"; traffic signs *s/* road conditions and rules; advertising signs *s/* particular products or services.

After a few minutes have students discuss why map makers use symbols instead of pictures of the objects or characteristics they wish to map. (Symbols are used by map makers to save time; to avoid cluttering maps with a confusing excess of pictures and words; and to show abstract characteristics such as rainfall, population density, or climatic type that may be difficult to show with pictures.) Show students pictures of some common objects and note the limitations of using them on a map (i.e., the difficulty of drawing hundreds of pictures of little houses, as well as the problem of leading the map reader to believe that all houses in the area mapped look like the house in the picture). If you have a good example of a poor picture map, have students evaluate it in terms of its clarity (Figure 11).

Ask students to name the symbols that map makers use. Accept all responses, and then have students suggest ways of classifying the symbol set generated. Symbols may be classified according to classes of objects symbolized (e.g., buildings, roads, water bodies), cultural versus physical characteristics, or abstract characteristics versus material objects. Again, accept all student responses, but probe to see if they can come up with the generic classes used by cartographers. The most general breakdown is between alphanumeric (words and numbers) and nonalphanumeric or nonverbal symbols. The latter are broken down into point, line, and area symbols (Muehrcke 1978, pp. 61-66; Raisz 1962, pp. 34-37). Each of these subclasses, in turn, contain a wide variety of symbols that may be used to represent an even wider array of objects or characteristics. The point to emphasize is that the same symbol may be used to represent different things on different maps (i.e., a dot of a particular size may be used to represent a small town, a particular type of business, a certain number of acres planted to a certain crop, or a certain number of animals or people occupying a given area).

Most students discuss, in turn, what kinds of things might best be symbolized using point, line, and area symbols. Start by asking students to discuss what type of symbol might be used to show towns, cities, people, factories, houses, cows, or waterfalls (point symbols). Point symbols are usually used to show settlement patterns

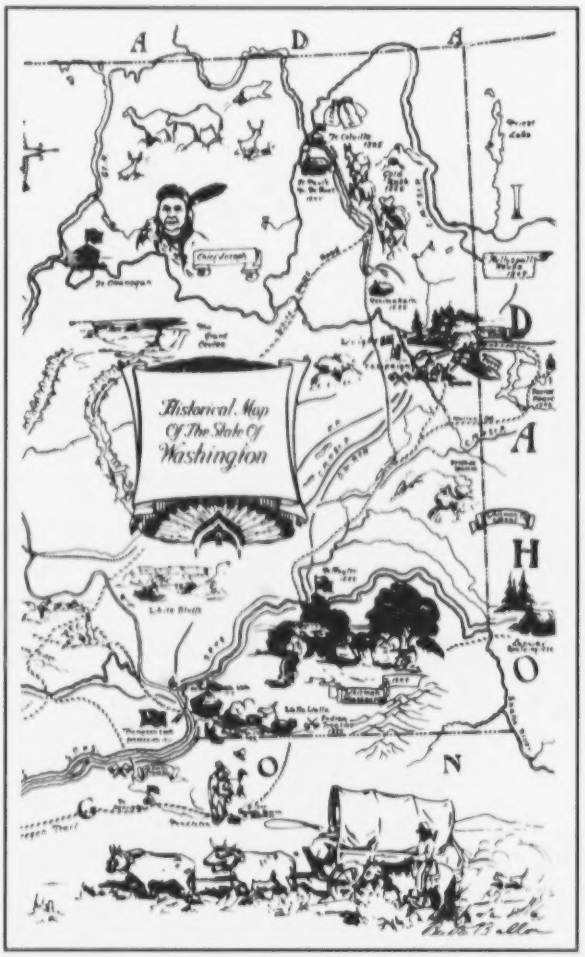

Figure 11. Portion of a pictorial map. Maps of this kind are often quite attractive, but cannot portray location and extent of features accurately. Source: American Association of University Women, Spokane Branch, 1931.

and other small or areally limited objects (i.e., dams or bridges, and things that can be counted or enumerated such as area or quantity of crop production, numbers of livestock, mineral deposits). Tell students that all symbols can be varied by size, shape, pattern, color, and intensity (light to dark). My typewriter keyboard, for example, has the following point symbols: , . / " < > : \ = + – * ^ $ @ & ! Further, tell students that good cartographers usually keep the purpose of any given map relatively simple, and they do not try to show too many different things or symbols on one map. Have them imagine how

hard it would be to read and understand a map that used all the point symbols on the typewriter keyboard.

Several additional activities may be included to reinforce and illustrate the discussion. The sandbox can be used to show a problem faced by the earliest map makers who found it difficult to make clear symbols and to show detail when scratching a map in sand or dirt. This problem may have prompted the invention of writing on clay tablets, bark, animal skins, or papyrus. The usefulness of blocks and other toys in making three-dimensional maps or models can also be demonstrated and their limitations for mapping larger areas (e.g., whole cities, counties, states) discussed. Another activity is to ask students to guess or suggest what geographic features the symbols from the USGS Topographic Symbol Sheet (Figure 12) might be used to portray on a map.

Finally, have students pick out as many different kinds of point, line, and area symbols as they can from several textbook maps, the state highway map, and topographic maps. If they start with the largest scale (most detailed) topographic map and work through progressively smaller scale highway and textbook maps, they should be able to see how symbols become less detailed and realistic, and more generalized as the scale decreases. The small-scale maps show large areas of the world on a relatively small area of paper or globe, whereas large-scale maps show small areas in relatively greater detail. For example, cities and towns that are shown as small dots on small-scale maps are often shown as areas on medium-scale maps and may require several large-scale maps to show them in their entirety. If map resources are limited, have students fill in worksheets individually or in small groups by carefully inspecting sample maps posted on bulletin boards or mounted with clips on large sheets of cardboard.

Lesson Six: Orientation

This lesson focuses on the fundamental geographical concept of orientation. At its conclusion, students should be able to (1) define *orientation* and tell several ways of showing it on a map; (2) determine the cardinal directions based on careful observation of the sun and its shadows, and relate these directions to local landmarks around the school, home, and community; (3) orient local maps (topographic, city, county) according to local direction determined from the sun or a magnetic compass; and (4) tell compass directions on a map and between places on a map. The lesson may be reinforced by having students take a self-guided walking tour either with or without a map, but which requires that students be able to "follow directions."

You, the teacher, should have an ample number of page-size US or state outline maps or state highway maps (one for every two or three students), a similar number of city, county, or local topographic maps, and some examples of compass roses (Figure 13). A magnetic compass and sun shadow board are optional materials. (City or county maps may be obtained free or at cost from local chambers of commerce, economic or tourist development agencies, and city or county offices.)

Initiate discussion by asking students, What does the word "orientation" mean? Accept all answers. *Orient* means "rising," or where the sun rises in the east. To be oriented means to know one's directions, where the sun rises and sets, and where north or south are, or to know in which direction important places are located with respect to one's immediate location. *Orientation* refers, then, to the direction in which a person is facing or

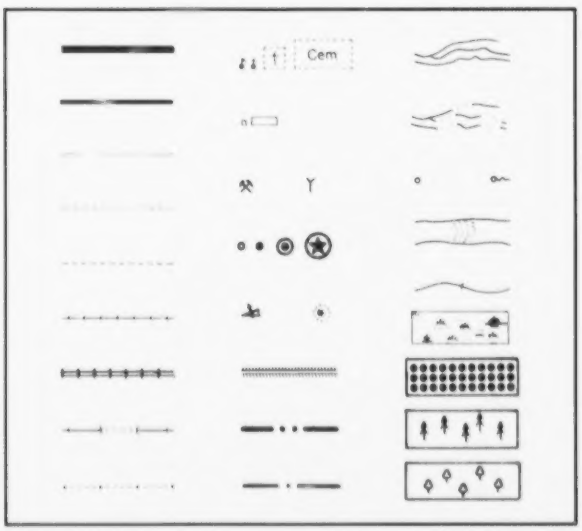

Figure 12. What would you use the following symbols for? Source: Adapted from USGS Topographic Map Symbol Sheet.

towards which a map is aligned. Most (but not all) conventional maps are oriented with north at the top and are said to have a "north orientation." Note that many medieval maps were, in fact, "oriented" with east at the top because that was the general direction in which Jerusalem, the Holy City, lay and the presumed location of Eden.

Focus discussion on the ways orientation is shown on maps, reviewing material introduced in Lesson 3. Refer students to a US or state outline map, or a state highway map. They should be able to observe that familiar shape, latitude and longitude or location grid, and familiar place names serve to orient these maps even if they lack a compass rose or directional arrow. When they later observe local topographic, city or county maps, call attention to arrows pointing to nearby towns or inclusion of the names of neighboring towns, counties, or states to orient the mapped area in its local context. Have students orient individual states on a worksheet by means of drawing a small north arrow by each and writing the abbreviations of neighboring states neatly along the borders (Figure 14). Conclude this introduction with a review of the names of the eight most commonly used directions (*N, S, E, W, NE, SE, SW, NW*).

Then ask students, What is your orientation now? If they are puzzled, tell them to point in the direction of east (where the sun rises), west (where it sets), north (the side of the building that is always in the shade at midday), and south (the side of the building that is always in the sun at midday, or where the sun reaches its highest point in the sky every day). You will probably get a variety of answers. Allow students to discuss which direction is which. When consensus is reached, have students review the relationship of the four cardinal directions to body orientation: when students face east, north is on their left, south on the right, and west behind their backs. Repeat the exercise with students facing in other directions. Playing the game "Simon Says," using compass directions, is a good way to reinforce mastery of local orientation and directions, and the game can be played in the classroom and in various parts of the playground.

Next have students fill in the eight major directions

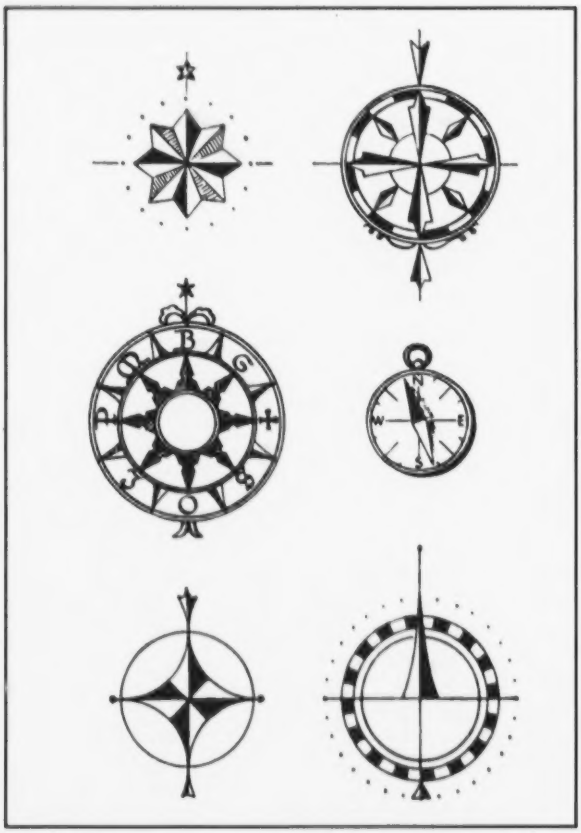

Figure 13. Examples of decorative compass roses. The arrow on the magnetic compass rose may be used to show magnetic declination. Source: Morison (1942).

on a ditto or photocopied compass rose (or better still design and draw one of their own) and orient it correctly on their desk so that the north arrow points in the direction of true north. Once students orient themselves and their compass rose correctly, have them tell the direction, and point toward various landmarks and locations around the school: In which direction is town or downtown? Home? The nearest park? Fairgrounds? College? Shopping center? In what direction do major streets or highways run? Which direction does the front of the school face?

Divide the class into groups of two or three students, and ask students to orient a city, county, or topographic map so that north on the map faces the north side of their classroom. Encourage students to locate the school and any landmarks that may be seen from the classroom window on the map to confirm the correctness of the map's orientation. If a magnetic compass is available, show students how to use it to orient themselves and the local map. Good introductions to compass and topographic map use are John Disley (1973) and Bjorn Kjellstrom (1967). The magnetic north arrow on the map should point in the same direction as the north end of the compass needle. (All USGS topographic maps show both magnetic and true north, whereas most maps show only true north.) In the northeastern US, the magnetic north pole lies between 0 and 23 degrees west of true north, and the difference is called the "west declination"; areas in the Midwest and western US have "east declinations" varying from 0 to 25 degrees. The declination problem is most extreme in northern Alaska where compass needles may point east or southeast because the north magnetic pole is located in northeastern Canada. The problem is compounded because the magnetic pole is not fixed but slowly moving. If compasses are used, they must be held level so that the needle is balanced and pivots freely, and away from large metal objects (including steel windows and steel beams in building walls) in order to get an accurate reading of direction (Greenhood 1964, pp. 60-66; Muehrcke 1978, pp. 312-29).

At this point, get students to study the US outline map and tell where the cardinal directions are on it. Get them to say how they know these directions. They should be able to identify bordering countries as well as many of the states. As they do so, they are using shape and place locations to infer directions, and relying on the myth that "north is always at the top of the map." Question them about other ways to determine map orientation. If they are stumped, ask them what the numbers along the edge of the map mean: 25, 35, 45, 70, 80. These are degree markers for latitude and longitude. Lines of longitude and latitude are also used for orientation, especially on small-scale maps and unusual projections. If students connect longitudinal grid ticks at the bottom of the US map with those at the top, they may see that orientation differs in different parts of the map according to the direction the lines of longitude run (Figure 15).

Students should be able to name the states (or provinces) immediately to the north, south, east, and west of their home state. Further drill might focus on which direction the Atlantic and Pacific oceans lie, and which direction they would have to go to get to Boston, Chicago, Cape Kennedy, and San Diego. If students are weak on basic place geography of the US, have them label all the states on the outline map. Additional copies of the map may be used to label important physical features and major cities. Similar orientation drills may be usefully repeated from time to time using state, city, or county maps.

Lesson Seven: Making a Photomap

In this lesson, students learn to (1) distinguish the general appearance of a variety of cultural and physical features on a large-scale aerial photograph of their local area; (2) review the map elements and apply the appropriate elements to the aerial photograph (or an acetate overlay of the photograph); and (3) consider verbal symbols to identify important roads and cultural features. You will need at least one blueprint or photocopy of the largest scale (1 inch to 200 or 400 feet are best for elementary school students) aerial photograph you can find for your school or nearby area (see Appendix A in Part One for probable sources). Mount the aerial photograph on cardboard or put it up on a bulletin board. Overlay the photograph with a large sheet of clear acetate or laminate it in clear plastic so that it may be recycled for future classes. (If no conventional aerial photograph is available, use good slides of the school area taken from an aircraft. Project the most suitable slides onto a large sheet of plain white paper that is fastened securely to a hard, flat wall surface. Have students trace the outlines of the most important buildings, streets, and other landscape features. The tracing can serve as the base map for this activity. It will not be precisely to scale because the angle at which it was shot will not be absolutely vertical, and there may be some noticeable distortion, but it will do. If slides are also unavailable, turn to Lesson Eight.) Also needed for this lesson are lined white paper, scissors, rulers, and rubber cement (or clear tape, or straight pins) for making

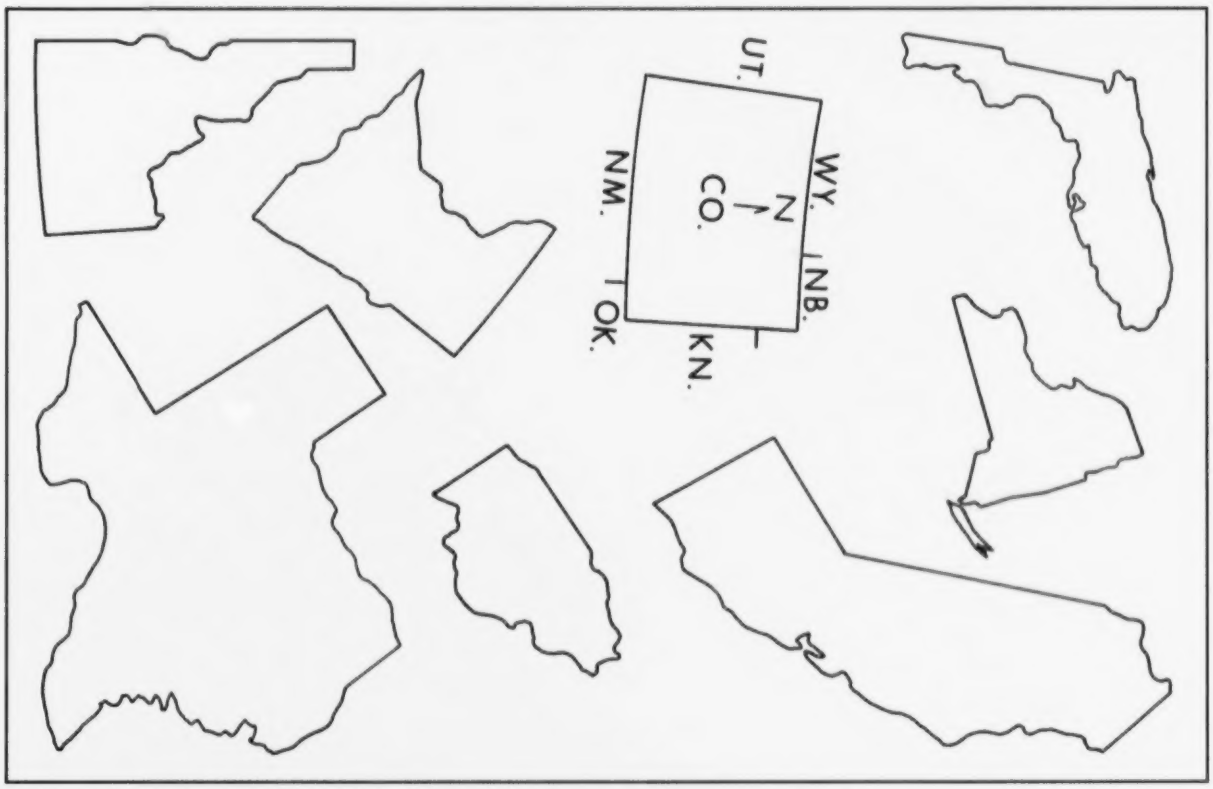

Figure 14. What states are these? Orient each by drawing a north arrow inside its boundaries and neatly writing the names of bordering states or countries where they belong, as has been done for the state of Colorado.
Source: Author.

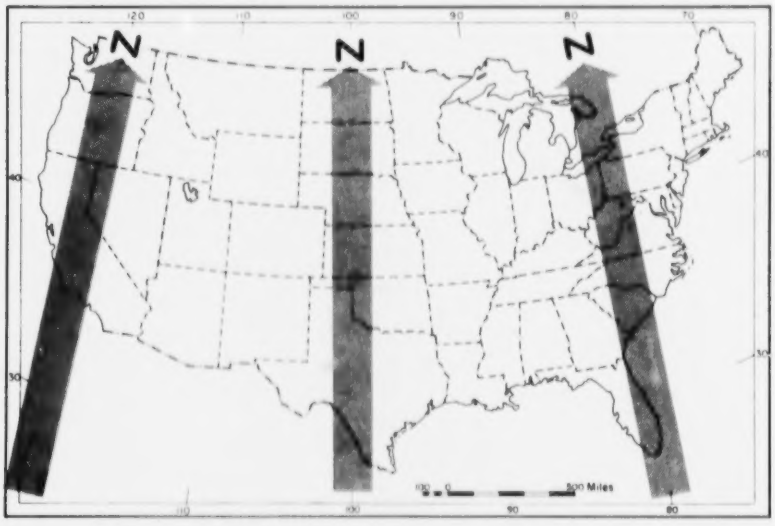

Figure 15. On many smaller scale map projections, the longitudinal grid reveals that north is really at a single point of convergence off the map, rather than merely "at the top."
Source: Author.

and attaching map elements, symbols, and labels to the photomap.

This lesson may be conducted with the class as a whole or divided into smaller groups depending on the availability of aerial photographs and class work habits. Ask students what things need to be done to the aerial photograph(s) to change it into a "photomap." Class discussion should elicit the need for *TOADS*, a legend, and lettering to label important features known to the class members (roads, parks, important places, and buildings). Students may also wish to label places of special interest to themselves (i.e., their homes, ponds, creeks, favorite play areas, favorite stores, hazard or problem areas in the community).

Focus subsequent discussion on deciding what to put on the map, and how each element and symbol should look (i.e., lettering size, style, shape, and color). Then delegate to individual students the responsibility for making different elements and labels. You may wish to devote another class period to making elements and labels because the tasks may be a little hectic logistically. Alternatively, you can have students complete the task as a homework assignment, but this option poses problems of design uniformity unless decided in advance.

Discussion about the design and placement of the various elements (Raisz 1962, pp. 112-24) should include the following:

(1) Titles. They are usually fairly prominent (in this case block letters one-half to one inch high) and centered or placed in a corner at the top or bottom of the map. A good title should be as specific as possible (i.e., Wiley School Area - Raleigh, NC - May 1984).

(2) Orientation. This element may be shown using a compass rose or a simple directional arrow pointing north.

(3) Scale. For most user purposes, both a verbal (1 inch = 400 feet) and a graphic scale (0 200 400 ft) are desirable.

(4) Author. The class may give itself as the map author or list individuals who provided the information mapped. Most of these elements are also placed at the corners of the map, usually along the bottom.

Students may elect to use distinctive lettering styles for different types of features (i.e., PULLEN PARK, *Perch Pond*, **Poole Rd.**). A legend should be made to tell the meaning of different lettering uses on the map (i.e., PULLEN PARK = a major landmark; *Perch Pond* = important water body; **Poole Rd.** = important street). Labels may also be glued, taped, or pinned flat on the photomap or onto its transparent covering. Differently shaped, colored, and lettered strips of paper may be glued to the tops of straight pins to make distinctive sets of easily installed and moveable symbols (Figure 16).

When finished, discuss how the photomap looks: Would the map look better and be easier to read if some of the elements or labels were neater, clearer, larger, smaller, or placed more or less conspicuously? Suggested improvements should be made on the spot, or as soon as possible, if so desired and time permits. As a follow-up, the students might want to invite the principal or other classes to see the map and explain to them how it was made. The map(s) might also be put on display in the school library or at a parents' meeting.

I completed this lesson successfully in two class periods with a whole class of about twenty students. I directed attention to a single aerial photograph of the community center, dictated the format for map elements and labels, and assigned every student one or two simple tasks. When I repeated the lesson using student groups, each operating on an aerial photograph of their neighborhood, it went less smoothly partly because I was unfamiliar with the students and because of the logistics of the lesson. In both cases, I provided students with a photocopy list of all street names on the aerial photograph and major landmarks in the area which I knew, and students labeled other landmarks important to them.

Lesson Eight: Making a Community Resource Map

This lesson may be substituted for Lesson Seven if a suitable aerial photograph or slide is unavailable for

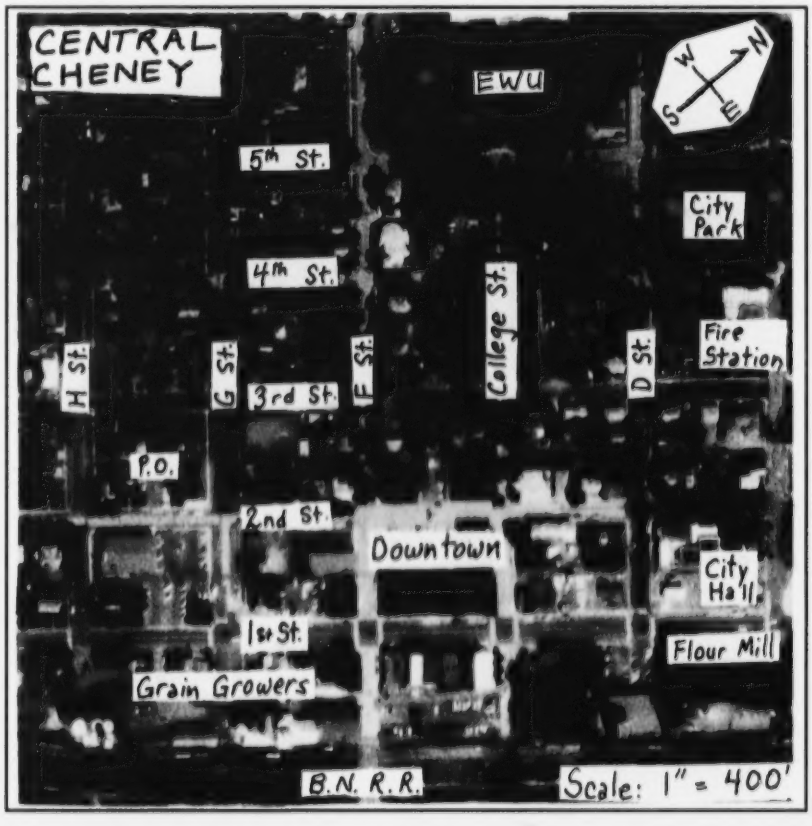

Figure 16. "Photomaps" are easily made by the addition of the elements of title, orientation, scale, author, date, source, and names of important streets and landscape features to a large scale airphoto. Source: Author and USDA airphoto No. AAN-4JJ, 135 (7-5-68).

making a photomap or used for purposes of enrichment, reinforcement, special studies, and a simple way of introducing Lesson Sixteen. In Lesson Eight, students correctly use map elements in the process of making large-scale street, county, or topographic maps into "community" maps. They invent and use a variety of map symbols, and correctly locate important community resources (i.e., landmarks, buildings, parks) on local area maps. They learn to recognize and employ class or other community members as informants or potential informants on the geography of different areas and aspects of the local community. They also learn to use ordinary travel (e.g., walking, bike riding, coming to school on the bus, or riding in an automobile with adults), telephone directories, newspapers, topographic maps, and other printed materials as sources of information about the community.

This lesson requires several copier reproductions or blueprints of a large-scale map of the school attendance area or local area around the school or community familiar to students. For rural areas or very small towns, copies of an appropriate portion of the 7½ minute topographic map of the area will suffice. Similarly, copies of appropriate portions of a county road map, planning department map, or the largest scale map of the community available from the local chamber of commerce may be used. One copy of each map should be provided for groups of three to five students. Tape or clip base maps to a piece of cardboard cut to provide a several inch (centimeter) margin around the map to provide work space and lend some durability to the map. Provide students with white paper, scissors, rulers, and pins or staples for making and attaching symbols, elements, and labels to the map.

The lesson may be done with the whole class or with student groups depending on the availability of community base maps and student work habits. If done with the class as a whole, use an overhead transparency of the base map and a set of colored pens. This approach demonstrates the use of students as informants but does not give them as much experience in map compilation, decision making, and task delegation as small group work.

Direct students' attention to a community base map mounted on cardboard. Distribute the map among groups or display it using an overhead transparency. Ask the children, What does this map show? Because the map shows familiar street names and perhaps some other familiar landmarks, students should be able to identify the locale. Then ask, What things doesn't it show? List answers to both questions on the chalkboard. Next, propose that the base maps be used to make several maps showing the location of important community resources—places that children and adults might need or want to use from time to time either when working or playing. Elicit discussion about the kinds of places that students think would be useful to map (e.g., ponds, parks, schools, churches, stores and shopping centers, apartments, hospitals, gas stations, banks, restaurants, and telephone booths). Classify and cluster items on the list to create the same number of desired resource maps as small groups (i.e., five separate topic clusters for five groups). Students should not be discouraged from attempting to map places or activities that may not exist in the base map area because learning what isn't there provides an important introduction to location theory and analysis.

Groups may be formed voluntarily or by assignment depending on class preference or experience. Voluntary groups making maps of the topics of their choice will be highly motivated and work together easily but may be at odds with other instructional objectives (i.e., balancing group abilities, reducing social or gender segregation, minimizing behavior problems). The task of each group is to (1) find out where the resources to maps are located, either on the basis of their own familiarity with the community, by observation on the way to or from school, by interviewing other class members or other persons in the community, or by using telephone directories or other sources of community data; (2) to decide what kinds of symbols to use on the map to show the location of resources being mapped; (3) to make and correctly locate these symbols on the map; and (4) to make and add the appropriate elements to complete the map (title, orientation, scale, legend, authors, date, sources of information). More than one class period will probably be needed to complete the assignment, given the need to consult diverse sources of information. If desired, some additional time may be devoted to viewing and evaluating the maps by the class as a whole. These maps, like the photomap and others produced by students, should be displayed where parents and other students and teachers may see them.

Teaching Map Skills: An Inductive Approach

Part Three

Lesson Nine: Making a Turf Map

In this lesson, students plan and make a sketch map of their neighborhood "turf" or "action space," and demonstrate their ability to correctly use the map elements of title, orientation, legend, author, and date. They need a twelve to fifteen inch (thirty to thirty-eight centimeters) square of newsprint for laying out a rough draft of their map and a similar sized piece of white butcher paper for making the finished map. Duplicate the formal assignment so that every student has a copy.

Give students a sheet of newsprint or other inexpensive paper for planning purposes and the assignment that follows.

> Make a sketch map of your neighborhood area so that you can show a friend who lives far away what your neighborhood is like: where you and your friends live and play, important landmarks, trails and paths that you use, where you go to explore, the location of special resources or places that you can go by yourselves (e.g., stores, schools, parks, churches, factories, work areas, woods, ponds, creeks, swamps, camps, treehouses, hideouts) and dangerous places or problem areas that you have to be careful about or stay away from.
>
> Your map should include the following elements: *TODAL* (title, orientation, date, author, and legend). You should make a rough plan of your map using the newsprint, showing what you want to put on the map and where you will put it, including the various places and things you wish to show, the symbols you wish to use, and the *TODAL*. When you've completed the rough draft, check it with me and I'll give you a sheet of good white paper for your final draft. Even your final draft should be drawn first in pencil, in case you make mistakes. Then, if you wish, use color for some of your symbols. The important thing is to make your map as complete and neat as possible. Also, make sure you leave room to fit all the elements (*TODAL*) on your map.

Before students start planning their maps, briefly discuss what elements they should include, and why scale, grid, index, and source elements are unnecessary. (Sketch maps need not be scaled because areas of greatest importance are often enlarged to show extra detail, and to draw the maps to scale would take too much time and effort. Grids and indexes are important only for maps of much larger areas showing many different places such as street maps of larger towns, or maps of states, countries or large regions. The source for these sketch maps is the author, and the title may indicate this—Jeremy's Turf: Mercer Island, Washington, 1945.) Also, discuss why the elements included should be within the map or along its borders, rather than on the back of the paper, or on another piece of paper. (Students often resort to these latter strategies when they have not planned carefully and run out of space. Failure to include these elements, especially the legend, in the map makes map reading difficult.)

Students should probably be given two class periods for this lesson; one period for making a rough draft, and the other for making the final copy. Finished maps should be prominently displayed around the room or on bulletin boards in school halls so that others in the class and school may study and enjoy them too.

Follow-up lessons might include having all students say something about their "turfs": favorite places, places or features of special interest, hazardous places, changes or improvements they would like to see made in their neighborhood. Authors and titles might be covered up, and students asked to guess whose map is whose, or what part of the country, town, or attendance area it shows. Discussion might focus on how and why neighborhoods differ; how and why student maps of the same area differ; what environmental problems exist in the school attendance area; and what, if anything, the class or community might do about them. This lesson may also be used to motivate writing lessons along similar lines: my favorite place; descriptions of streets, yards, vacant lots or rooms; what I would like my neighborhood to be like in five years; my favorite activity; a typical Saturday in spring, fall, winter; where I would like to live when I grow up.

This assignment is valuable; it builds students' self-concept because students are experts on their local environments. "Turf maps" show that students have a home, and the power to modify and improve their local environment. These maps are also great aids in getting students and teachers to know one another better. I strongly urge teachers to make a map of their own "turf" when they were the age of their students and share the map with the class. Your map can serve as a good model for student maps and demonstrate that you, too, were once young and had some interesting adventures and play areas (Anderson 1976).

Lesson Ten: Using Map Grids

This lesson gives students practice using grid systems common to most large- and medium-scale city and state maps. Students who can use these systems for locating places will be able to master the geographical grid (latitude and longitude) system easily. After completing this lesson, students should be able to use map indexes to obtain the grid addresses of places on a map and to find places on the map using their grid address. Materials needed for this lesson include copies (one for every two or three students) of state highway, city, or county maps with an index of places and grid system for locating them, and a worksheet of practice problems for students. This lesson should take only one class period to complete.

Have students study the map and locate the index. Then ask, What does a map index tell us? How does it

tell this? Why do some maps have or need indexes? (A map index provides a grid address for places named on the map. The grid address may be a simple system using whole numbers and/or letters of the alphabet, or it may be a more precise pair of numbers relating to a military or geographical grid system.) Have students find and tell the grid address of several places using the index.

Next, have students look at the map and locate the grid lines and the numbers or letters that identify individual cells within the system. You should diagram the system on the chalkboard or an overhead transparency, then point to the different cells and have students tell the address of those cells. Reinforce their knowledge of orientation by having them give you the address of cells, rows, or columns that you identify by direction; that is, What is the address of the cell in the extreme southwestern corner of the map? What number (or letter) identifies the easternmost column of grid cells (Figure 17)? Further drill may involve giving students a grid-cell address and having them identify a feature within it; that is, What large city is located in grid cell F-2? Note that on some maps grid lines are omitted, which forces reliance on numbers and letters along the edge of the map (an implied grid system).

Test student comprehension with a series of extemporaneous questions that require students to state the grid address of places, locate them on the map, and tell something about them. Conclude the lesson by having students use the index and map to complete a worksheet of appropriate problems (Figure 18).

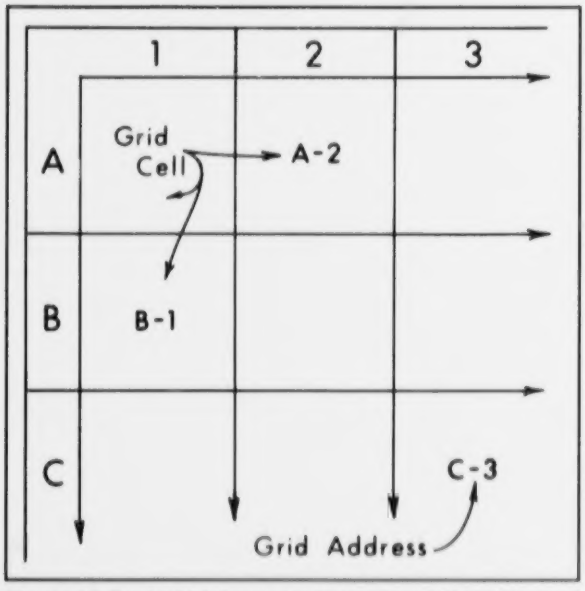

Figure 17. Typical highway or street map grid system and terminology. Source: Author.

Using the map index and map grid, find the grid addresses of the following places, then locate them on the map and answer the questions about them.

	Grid address	Nearest town	Nearest river
Archer Lodge			
Brinkleyville			

Figure 18. Sample map index and map grid worksheet. Source: Author.

Lesson Eleven: Map Scale

This lesson gives students a better understanding of what map scale is and how it can be used to measure distances and areas on maps drawn to scale. When students complete this lesson, they should be able to define *map scale* in their own words, tell three ways of showing scale on a map, and use graphic scales to measure distances between points on maps. Materials needed for this lesson include a state highway map and a ruler for every two or three students, a plain sheet of white paper for every student, and a dittoed worksheet of scale and map measurement problems based on your state map. Scale problems assume that students are capable of multiplication and division, although the measurement method taught here does not require these skills.

Start the lesson by asking, What is map scale, or what does the scale of a map tell or show us? (The scale of a map tells what a given distance on the map actually represents in the real world.) Give students several verbal or ratio scales and have them tell what the scales mean in practice. For example, a verbal scale of one centimeter equals twenty kilometers means one centimeter on the map equals twenty kilometers on the ground, two centimeters on the map equals forty kilometers on the ground, and three centimeters equals sixty kilometers. A ratio scale of 1:24000 means one inch on the map represents 24,000 inches or 2,000 feet on the ground. Test understanding of these concepts by asking students simple questions based on multiple map units. For example, if map scale is one inch equals fifty miles, and measurement on the map shows that town *A* is three inches from town *B*, what is the approximate distance between them?

Then ask, What are the different ways of showing map scale? Students with good memories should recall from Lesson Three the common ways of showing map scale: linear, graphic, or bar; verbal; and representative fraction, or ratio (Figure 8, Part One). A graphic or linear scale shows representative distances marked off on a bar (Figure 19). A verbal scale makes a statement: one inch equals one-half mile. A ratio or representative fraction is the most precise way of showing scale. For example, 1:31680 means that one unit of measure on the map represents 31,680 units of the same measure on the ground.

Maps can be made at any scale. If map makers want to map small areas (e.g., a room, the school grounds) in

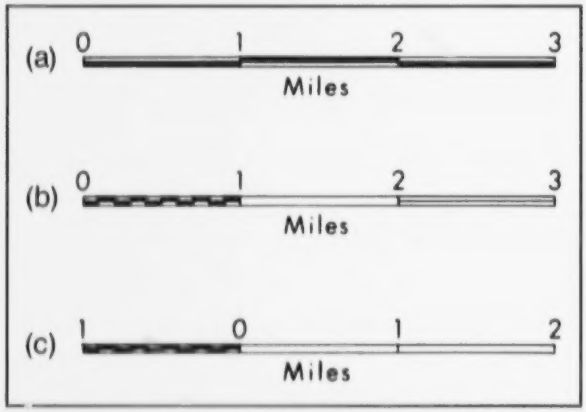

Figure 19. (a) Simple graphic scale bar; (b) graphic scale bar with greater detail in first segment; (c) graphic scale bar with greater detail to the left of zero. Source: Author.

great detail, they make large-scale maps whose ratios are 1:500 or less. If they want to map medium-sized areas with moderate amounts of detail (e.g., neighborhoods, small towns), they make maps at ratios of between 1:2000 and 1:50000. If they want to map large areas of the world with relatively little detail, they make maps at ratios of 1:500000 or larger. Tell students that the larger the number to the right of the colon in the representative fraction means the smaller the scale. Students should be able to explain in their own words why large-scale maps can show more detail about a place than small-scale maps. If one inch represents five or ten feet, you can show individual pieces of furniture in a room; if one inch represents fifty to 100 feet, you can show trees, buildings, and roads at their actual scale, and there is room on the map to name many places like parks, schools, and ponds. If one inch equals five to ten miles, however, roads can only be shown as thin lines, large cities as small blobs, and there is no space to name any but the most important places and features (Figure 20).

Conclude this introduction to scale by noting that larger scale maps are usually more accurate than smaller scale maps, and by telling this anecdote.

> There once was a town that resolved to make the most accurate town map in the world. Town officials decided to make a map at a scale of 1:1. If the town were square in shape and measured two miles on a side, how big would their map have to be at this scale? What problems do you suppose they had in making such a big map? The only place big enough to work on the map was the football field on the edge of town and, even then, they could only map a small portion of the town at a time. They soon found that it took enormous rolls of paper that had to be taped together. They also had to be careful in case their feet or knees poked holes in the paper as they moved around to draw in the necessary features. The project was finally abandoned because a sudden storm rained on part of the map, and because the officials realized that there would be no place large enough for a finished map to be displayed. How big would a map of your town or township be if it were made at a scale of 1:1, 1:2, or 1:4?

Now refer students to the state highway maps and ask them to state its scale. If students have mastered multiplication, they can use rulers to measure straight-line distances on the map. Partners should take turns making measurements. Use a wall map to demonstrate the use of the ruler to make measurements and show the necessary arithmetic on the chalkboard. For example, the measured map distance between *A* and *B* is six inches; hence, if map scale is one inch = 20 miles, then 6 X 20 = 120 miles from *A* to *B*.

If students are unable to multiply, then use a blank sheet of paper, mark distances off along its edge with a pencil, and compare them with the graphic scale on the

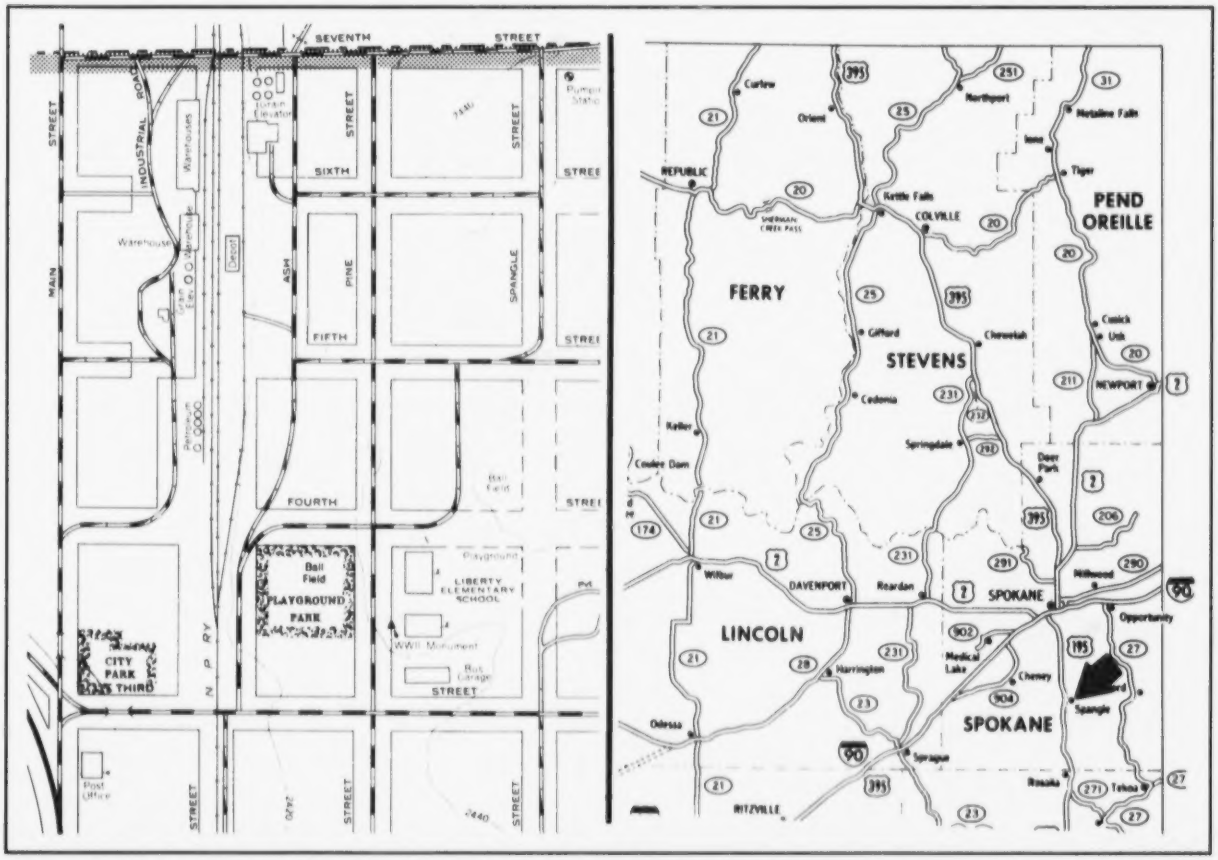

Figure 20. Small-scale maps have much less detail than large-scale ones. Streets and even buildings can be shown on a large-scale (approximately 1:4800) map of Spangle, Washington (left); whereas on a small-scale (approximately 1:2000000) map of Washington State (right), Spangle is just a dot. Source: City map, Spangle (1969) and Washington State Department of Transportation map (1981).

map. This method requires great care for accurate results, but it is also the easiest way to measure distances along roads, boundaries, or other winding features on a map (Figure 21). Note that on many maps the graphic scale is shown in greater detail to the left of zero (Figure 19), and that students must be careful to avoid error in using these scales.

Provide students with plenty of measurement practice. Give them worksheets that help to show the multiplicative relationship between map distance and actual distance (Figure 22). A good follow-up exercise that students can do on their own is to find out the straight-line or road distance from their homes to school, homes of their friends, nearest shopping center, fire station, and park using a street or topographic map showing the school attendance area. The map is best tacked on the wall or taped to a piece of stiff cardboard to minimize wear and tear.

Worksheet questions should begin with relatively short distances and slowly increase to longer ones, in order to build student confidence and skill. Make sure you do the assignments yourself first so that you can identify any difficulty that students may encounter. This lesson takes one or two days depending on the level of the students and the amount of practice needed to develop the desired level of skill. If students master the skill readily, devise more complex problems (e.g., determining the air miles covered on a cross-country flight stopping at various cities). For gifted students, pose still more complex problems (e.g., measuring curvilinear route lengths or measuring approximate lengths of a coastline or boundary). Scale problems represent an excellent opportunity to demonstrate the application of various mathematical skills and give students map-use and computational practice.

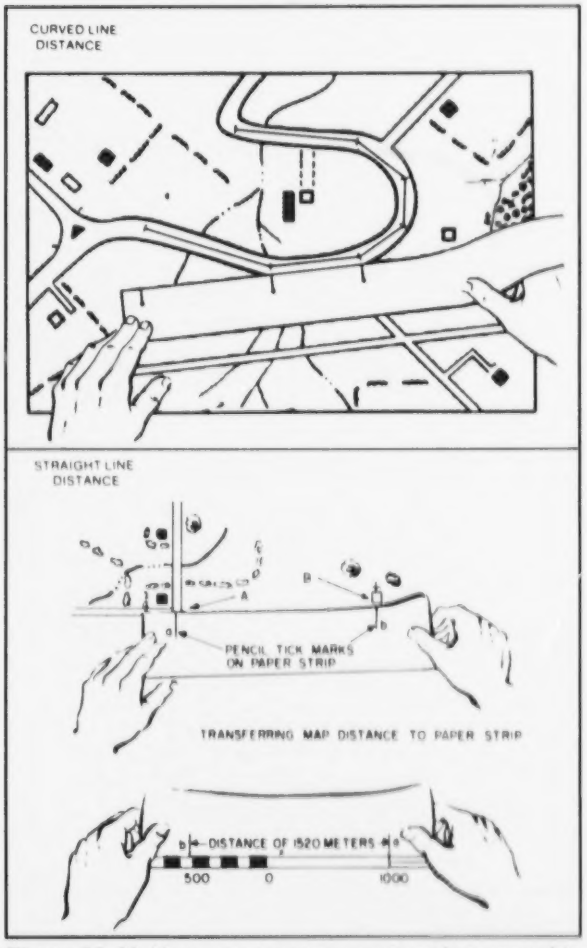

Figure 21. Making map measurements using a graphic scale bar. Source: Muehrcke (1978, Figure 7.9), Courtesy of JP Publications.

Determine the scale of this map, and state it in verbal and ratio forms.

Verbal scale:_____ Ratio scale:_____

Find the straight-line distance from Spokane to Seattle in inches:

_____

Now convert this straight-line distance in inches to miles. Include your calculations in the answer space.

_____ X _____ X _____
(distance in inches) (scale: miles per inch) (distance in miles)

Follow the same procedure to find the distance from Spokane to Richland, Moses Lake, Wenatchee, Vancouver, Hoquiam, and Cape Flattery.

Measure the outer dimensions of the map, convert them to miles, and determine the approximate area of the map. Show all measurements and calculations in the answer space provided.

Figure 22. Example of a scale map measurement worksheet. Source: Author.

Lesson Twelve: Making a Scale Map

This lesson allows students to apply what they learned about map scale in the previous lesson to the actual making of a scale map of a familiar small area. They will gain practice in making accurate measurements, recording data on a sketch map, making appropriate calculations to convert actually measured distances to scaled measures, and plotting these on paper to make a scaled map. This assignment takes several days.

Materials needed for each student or team of students include several sheets of plain white paper, yardsticks, tape measures, or measuring tapes. (Where resources are scarce, students may make their own measuring tapes with strips of plain paper and masking tape or use their bodies for measuring.) If students are mapping rooms or other rectangular spaces, graph paper ruled at four to five squares to the inch can be used for plotting their finished maps because it provides a "built-in" scale. Although the assignment is easiest for students who have mastered short division, those who are unable to divide can get by using simple conversion ratios (e.g., one foot to the inch, one yard to one inch) or by drawing an extended, detailed scale bar on a straight-edged piece of cardboard.

Introduce the lesson by saying, Imagine that you are an explorer or archaeologist out for a pleasure hike on your vacation, and you discover the ruins of an ancient cluster of buildings. You would like to make a detailed scale map or plan of the ruins, but you have no equipment with you except for pencil and paper. Could you make a scale map?

After class discussion, students should be able to tell how they could make a sketch map showing the general arrangement of rooms, walls, and openings in the ruins in relationship to one another and the site. Use the chalkboard or overhead projector to show students how to

make a sketch map of the outline of your classroom. Then ask, Is there any way that you could make at least some rough measurements of the approximate size of the ruins and its most important parts? Tell students that various parts of the human body—hand span, arm spread, or feet—can be used for measuring small areas such as wall openings and small rooms, and steps or paces (two steps) may be used to measure large rooms, the outside of buildings, and other more widely spaced objects around the ruin. Have students pace off the perimeter of the classroom and record the length of each wall on your sketch outline map.

Then ask, Now that you have made a rough sketch map of the ruins, measured important distances with your body and paces, and recorded these on your sketch map, can you convert these data into a neatly drawn and scaled map that will be useful to other scientists? Applying the concepts of scale learned in the previous lesson, students should understand that if they know their body measures and average pace length, they can convert these to standard measures. For example, my hand span is about nine inches (twenty-three centimeters) from thumb tip to the tip of my little finger, my out-stretched arms extend about five and three-fourths feet (one and three-fourths meter) from finger tip to finger tip, my favorite shoes measure about twelve inches (thirty centimeters) from heel to toe, and my pace averages about 5.5 feet (1.6 meters). If I am making a page-size plan of my office, which measures about four by eight paces, I may scale my drawing: one inch equals one pace; a page-size map of a classroom fifteen by twenty paces might be scaled one inch equals three paces (one centimeter equals one pace).

When selecting a scale for any map, ensure that the drawing will fit a piece of paper of reasonable size. The map should not be so large that there is no room for peripheral elements (title, orientation, scale) or so small that there is no space to draw in or label important details. At the elementary level, choose scales for which the conversion calculations are relatively simple. Working with scale conversions provides practice in multiplication, division, fractions, decimals, and the metric system. At this point, use a ruler or yardstick to show students how to convert a sketch map with its measurements to a finished map.

The assignment is for students either individually or in small groups to make a scale map of some favorite place, room, or portion of a room. Give them the choice of using body measures or a conventional tape measure. Briefly review the five steps for completing this assignment.

(1) Select the area you wish to map;

(2) Go to that area and make a rough sketch map that includes the approximate locations of important objects within the area (e.g., trees, big rocks, playground equipment, furniture);

(3) Measure the perimeter of the area, distances between various objects, points along the perimeter, and the width and length of objects, and record the measurements on the sketch map;

(4) Decide on an appropriate scale for the finished map and convert the measurements accordingly, perhaps plotting these on a second "clean" copy of the sketch map;

(5) Decide on an appropriate origin point and orientation for the map. Plot the scale measurements, perimeter, and object outlines carefully on a sheet of clean white paper. Include title, orientation, scale, author, date, and source of data.

I made a scale map of the corner of the study in which I wrote this lesson. The sketch map included the bookshelves and windows that bounded the space on two sides, the desk top, and my word processing system. Given the clutter, I found it quickest and most convenient to use a tape measure for measuring distances. It took me about thirty minutes to make the sketch map and record the measurements (Figure 23). I selected a scale of one-half inch to one foot because the total space mapped measured about eight and one-half feet square, and because I wanted the map to fit less than one-half page in the *Journal of Geography*. I recorded all measurements in inches, made a table of distances arrayed in descending order of magnitude, and then carried

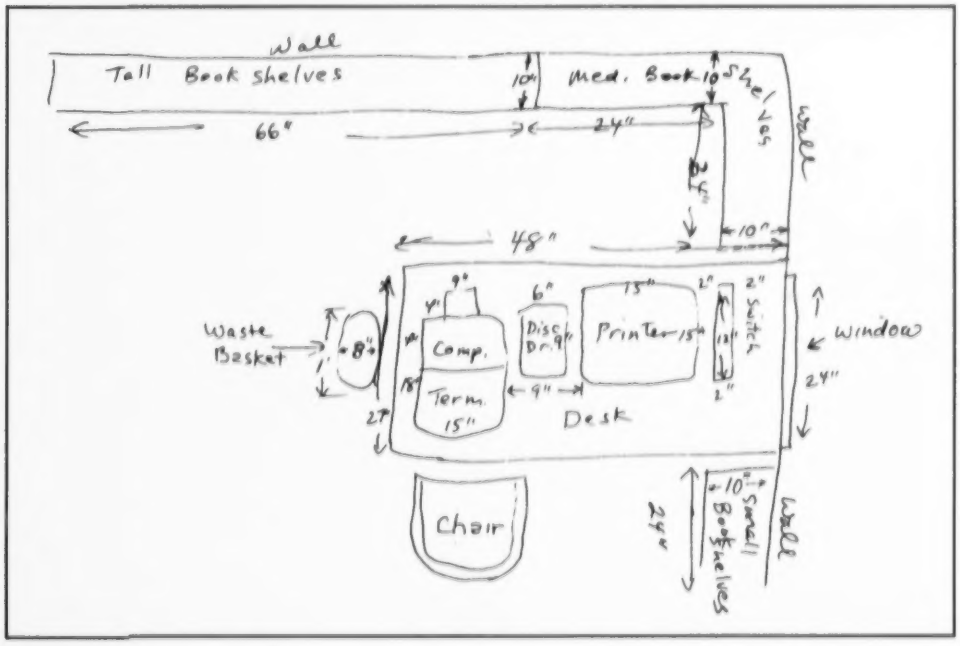

Figure 23. Rough sketch of a part of Jeremy's study with measured dimensions recorded. Source: Author.

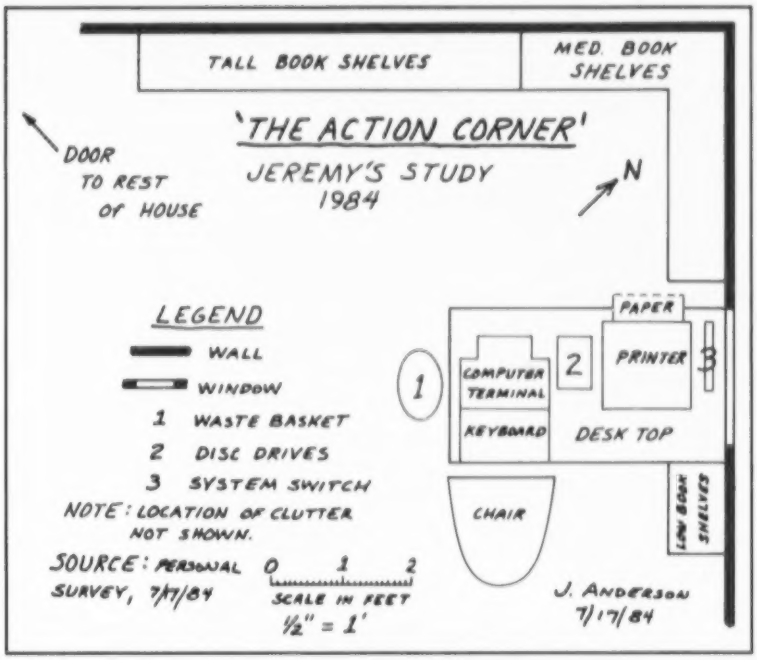

Figure 25. Finished scale map of Jeremy's "Action Corner." Source: Author.

out the scale conversions (Figure 24). I converted the inch measurements to feet and fractions of feet. And then, by simple multiplication of 0.5 times the distance in feet, I got the number of inches my map measurement should be. The origin chosen for drawing the map was a corner of the room, but the end of any bookshelf would have worked equally well. Figure 25 shows the finished map drawn to scale.

If students need practice, have them make a map of objects on top of their desks. If students are using body measures for their maps, tell them to develop nested pairs of body measures for small detail and large scale (i.e., how many shoe lengths are in a given person's pace?). Emphasize that measurements will be most accurate if students don't strain but simply walk or stretch normally. Tell them to take several measurements to determine average lengths of body measures. Remind students that the larger and more complex an area they choose to map, the more measurements they will have to make and the smaller the scale of the final map. Check with each student or team to see that they do not select too large or comp' ɔx an area to successfully map in the time available. The squareness of much of our built environment makes rooms relatively easy to map.

Actual measure in inches	Converted measure in feet	Converted measure in inches
66	5.50	2.75
48	4.00	2.00
34	2.83	1.42
27	2.25	1.13
24	2.00	1.00
18	1.50	0.75
15	1.25	0.63
12	1.00	0.50
10	0.83	0.42
9	0.75	0.38
8	0.67	0.33
6	0.50	0.25
4	0.33	0.17
2	0.17	0.08

Figure 24. Table of recorded dimensions and converted dimensions for scale map of Jeremy's study. Source: Author.

For a second assignment, divide the school building or school grounds into sections. Have each student or team map a section at a given scale using a consistent set of symbols devised by the class as a whole. Join the resulting maps of each part into a larger whole. This assignment is one where students should be encouraged to give careful thought to aesthetic design of map symbols, elements, and layout. It takes at least two class periods to complete, in addition to the time needed for students to make sketch maps and measurements. You may wish to recruit some knowledgeable parents or adults from the community to help with the latter stages of this assignment, because you may have students clamoring for assistance in deciding appropriate scale and converting field measures to map distances. As always, devote some time to displaying, discussing, and praising the finished results. David Greenhood has a useful discussion of how to make such maps (Greenhood 1964, pp. 199-210).

Teaching Map Skills: An Inductive Approach

Part Four

Lesson Thirteen: Map-Reading Review

Although the preceding lessons are self-evaluating in terms of built-in performance objectives, more comprehensive evaluation is occasionally desired. This lesson is designed to help students review, integrate, and apply concepts learned in Lessons Five, Six, Ten, and Eleven to the reading of a large-scale city or county map. Materials needed include one dittoed or xeroxed large-scale map with the desired elements (Figure 26), and one dittoed worksheet (Figure 27) for each student. Satisfactory completion of this exercise will demonstrate student ability to use symbols, legends, scale, orientation, index, and grid in map-reading and map-use to give directions for way-finding. Division of the worksheet into specific skill sections, as in the example provided, will allow this exercise to be used as a diagnostic tool to determine student mastery of individual concepts. The lesson should take one class period, and may be considered the concluding lesson of a map skills unit core.

The exercise provided is only one example of the kinds of maps and questions that might be used in a unit review. The map example shown is a slightly reduced copy of a part of a city planning commission street map (with index, grid, symbols, and some feature names added). The aim was to create a realistic map that was slightly less complex than a conventional state highway or commercial city map. State highway or commercial city maps may be used, but only if their design and content is suitable, and students are capable of using them. If students encounter some difficulty with this example, make up several different worksheets for the map used. Spend one period teaching the objectives using one worksheet, and use a subsequent period and a second worksheet for evaluation.

Lesson Fourteen: Using the Geographic Map Grid

The geographic grid comprised of latitude and longitude provides a universal locational reference system that can be used anywhere on the earth's surface. At the conclusion of this lesson, students should be able to explain what latitude and longitude tell about location on the earth's surface, to use an atlas index to obtain the latitude and longitude of given places, and to locate those places on atlas or other maps with geographic grids on them. Materials needed include a globe, a large wall map of the world with a grid net of latitude and longitude lines, and student atlases for every two or three students with place indexes showing the latitude and longitude of places. Your instructional task will be aided by relevant overhead transparencies, filmstrip or film materials from your school or district media center, and Figure 28. The lesson should take one to two days.

Start the lesson by asking students to define latitude and longitude in their own words and to tell for what purpose they are used. (Latitude is a measure of the angular distance in degrees, minutes, and seconds of a place north or south of the equator; Moscow, capital of the Soviet Union, is 55° 45′ north latitude; and Washington, DC is 38° 50′ north latitude. The lines of latitude drawn on maps run east and west, and are also called parallels. The equator, latitude 0°, is the parallel that divides the earth's surface into northern and southern latitudes and hemispheres. Longitude is a measure of angular distance in degrees, minutes, and seconds of places east or west of the prime meridian. The prime meridian is the imaginary line that runs through the Greenwich Observatory, London, England and divides the earth into western and eastern hemispheres. Places can be as far as 180 degrees east or west of the prime meridian, and the 180-degree meridian also serves for most of its length as the International Date Line (except for several jags between the Chukhotsk Peninsula of the Soviet Union and the Aleutian Islands of the US, and a detour east around some island groups in the South Pacific). The longitude of Moscow is 37° 37′ east, and that of Washington, DC is 77° 0′ west. Lines of longitude run north and south, converging at the North and South Poles, and are also called meridians.) Point out the lines of latitude and longitude, especially the key ones, on the globe and wall map, and discuss in which hemispheres the various continents are located.

Tell students that the system of lines of latitude and longitude is called "the geographic grid." Ask them why it was invented. Just as we use streets and street numbers (e.g., 305 W. Riverside, 2554 N. Maple) to tell the location of buildings in a city, so too we need a way to specify the location of places on the surface of the earth. Greek map makers invented the geographic grid more than 2,000 years ago. This system permits us to accurately describe the location of any place on the surface of the earth. Beijing, China is 40° 7′ N., 115° 58′ E. in the index of an atlas. One minute of arc is one-sixtieth of one degree. Because minutes are also subdivided into seconds of arc—one second is one-sixtieth of a minute—places can be located on the surface of the earth to an accuracy of within about 100 feet (thirty meters).

Latitude and longitude are valuable for locating moving objects (e.g., ships at sea or large storms). If we are told that a hurricane is at 29° N., 78° W. and moving in a northwesterly direction at twenty miles (thirty-two kilometers) per hour, we can readily locate it on a map and predict when and where it may first affect a coastal region. In similar fashion, the atlas index may be used to find the location of political, sports, or cultural events. Latitude helps us to know about the temperature and day length of a place at different times of the year. Longitude forms the basis for time zone boundaries. There is one time zone for each fifteen degrees of longitude, although the actual time zone boundaries set by different countries often follow topographical or political boundaries rather than meridians.

Give students some practice drill in extrapolating degrees because the grids on most small-scale regional maps show only every five, ten, or twenty degrees. Moreover, the grid on many maps is only shown on the edge of the map or over water, and parallels are often curved as a result of the map projection used for the map. These

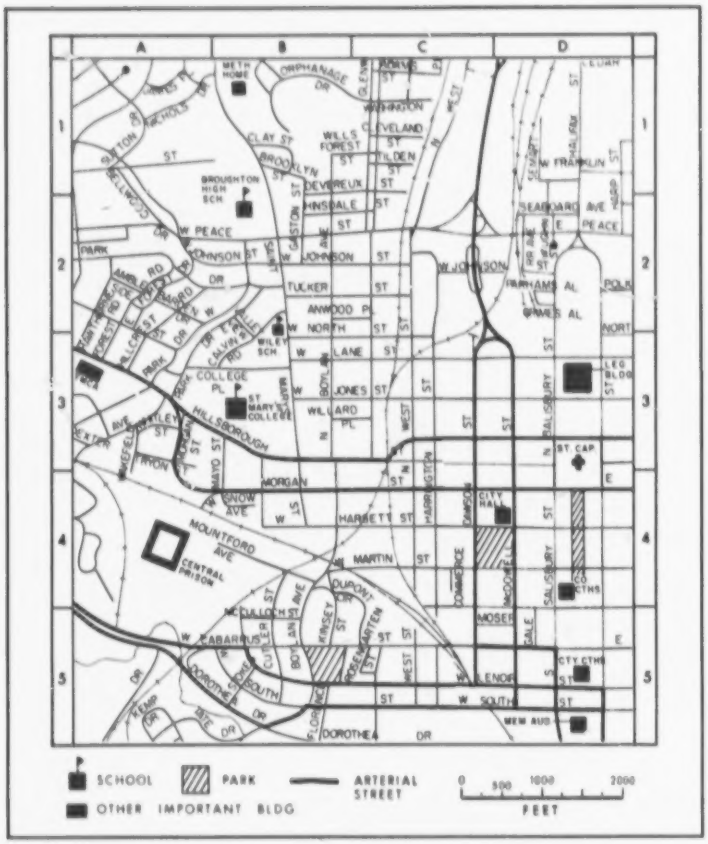

Figure 26. Sample map (west-central Raleigh) for map-reading exercise. Source: Adapted from Raleigh City Planning Commission map, 1978.

(1) Introduction
- A. What is the title of this map? _____
- B. What does it show besides streets? _____
- C. Draw the symbols used on the map to show:
  schools_____ railroads_____ parks_____
  arterials_____ other major buildings_____

(2) Finding places on the map
- A. This map has a grid system to help map users find important places. What symbols are used for the grid system on this map? _____
- B. Create a map index by determining and writing down the map grid address or grid location for the following places:
  State Capital_____ Broughton High School_____ Wiley School_____ YMCA_____
- C. Show that you know where these places are on the map by circling each one.

(3) Orientation and compass directions
- A. Where is the direction *north* on this map? _____
- B. What direction is City Hall from Central Prison? _____
- C. What direction is Wiley School from Broughton High School? _____
- D. In which two directions do each of the following streets run?
  Boylan Avenue_____ Peace Street_____ Bellwood Drive_____

(4) Giving directions
- A. Study the map and then tell how you would direct a person to walk from Wiley School to the YMCA: _____
- B. How would you walk from Broughton High School to the State Capital? _____

(5) Measuring distances on the map
- A. Measure the graphic scale with a ruler and complete this verbal scale statement: 1 inch represents ____ feet.
- B. How many feet is it from Wiley School to Hillsborough Avenue (along St. Mary's Street)? _____
- C. How far is it from St. Mary's Street to the Legislative Building (along Jones Street)? _____

Figure 27. Map-reading exercise keyed to west-central Raleigh map. Source: Author.

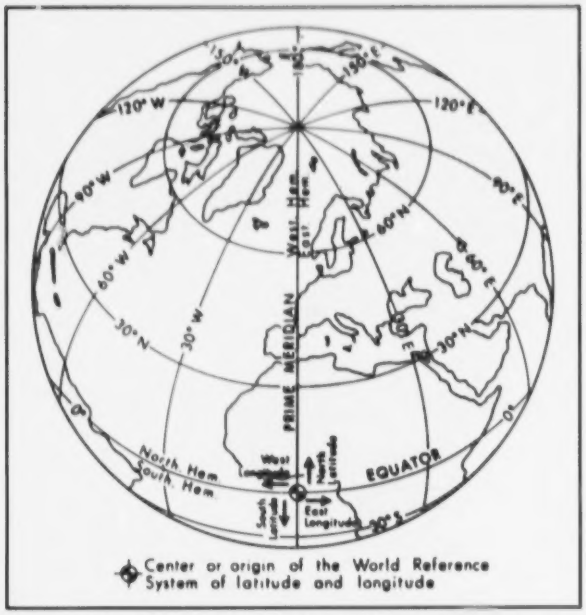

Figure 28. The geographic grid provides a comprehensive system for specifying the location of a place anywhere on the earth's surface. Source: Adapted from Castner (1981, p. 48).

problems make estimation of latitude and longitude more difficult, but not impossible, for sharp-eyed map readers who are able to anticipate the way grid lines curve. Encourage students to estimate the approximate latitude or longitude of important state, national, or county boundaries (e.g., the latitude of the Iowa-Minnesota boundary, the longitude of the westernmost Aleutian Island).

Finally, give students worksheets with questions that require them to use both the index and atlas maps. If sufficient atlases are not available, make up worksheets with latitude and longitude provided, which students can use to locate particular places on wall maps (e.g., name the city found at each of the following locations and tell what they have in common). Alternatively, provide students with a list of places and have them determine their latitude and longitude from a wall map or globe. This exercise, however, requires special care for accurate extrapolation. Another good drill is to provide students with a series of paired latitude-longitude locations that form the outline of a continent for them to plot on a sheet of graph paper. Paper ruled at five or ten squares to the inch, with bolder lines every inch, is best for this purpose (Figure 29).

The practice and evaluative phases of this lesson may be set up in a learning center. The rationale and use of grid systems is well treated at an elementary level by Henry Castner (1981, pp. 44-51) and in greater detail but with superb clarity by David Greenhood (1964, pp. 3-13).

The final two lessons of this series give students additional practice in map-making and may be used at any time to provide enrichment activities for science or social science units.

Lesson Fifteen: Making Outline Maps

Students and teachers often need outline maps on which to plot specific data for illustrating a report or for instructional use. Although outline maps are available commercially and photocopy machines save much labor, the ability to make your own is a valuable skill. Maps found in atlases and textbooks often include information that is unnecessary or undesirable on an outline map—what cartographers call "noise." At the conclusion of this exercise, students should be able to locate maps of appropriate scale, and make outline map tracings from them that include only desired information and essential elements. Materials needed are a selection of appropriate reference sources (e.g., atlases, encyclopedias) in which students can find a wide array of maps from which to trace, tracing paper, drafting tape, and pencils with good erasers.

Start the lesson with several motivating questions: Suppose you need to make a map of some place for a report, or you need an outline map of a country or state to use for making a number of maps showing different kinds of information about that place. How would you meet that need? (The obvious answer is to look in an atlas or appropriate book for such a map.) Now suppose you find a map of the area you need with the information you want, but it also shows a lot of things that you don't need on your map. Besides, it's in a book, and you don't have a photocopy machine handy. How can you make the map you need? Class discussion should conclude that the best way is to trace the map, leaving off extraneous details but including desired ones. Briefly review what elements the map might include.

The map-making assignment may be convergent or divergent, depending on class needs and abilities. A divergent task might be to have each student plan a two-week vacation trip around the state or country, and make a map showing the places to be visited, the routes used, significant political boundaries, and the starting and ending points. The map would probably need a legend

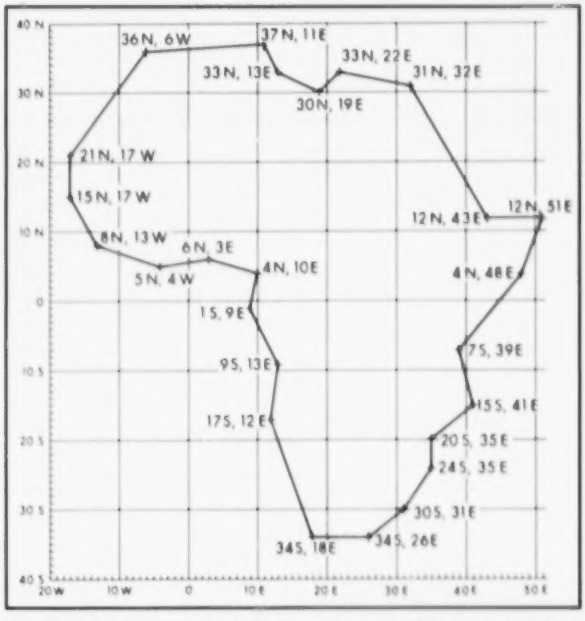

Figure 29. Continental outline map of Africa created by plotting 27 pairs of coordinates of latitude and longitude of prominent coastal points on graph paper. Such an exercise also teaches students how cartographers generalize the shape of an area, an important concept for computerized map-making. Source: Author.

to show different modes of travel, overnight rest stops, and special attractions. It would also need other elements such as title, orientation, source, and scale.

A convergent assignment would be to have students make an outline map of their country, or a region within it, showing a selected group of features (e.g., cities with more than 500,000 people, major political boundaries, major rivers) (Figure 30). In this case, provide students with a list of the features to be shown. To assist students, discuss the necessary steps for making the map: (1) decide what information you want on the map; (2) find a base map of appropriate scale with needed information; (3) assemble materials (i.e., tracing paper, drafting tape, pencil, eraser); (4) decide on symbols to use for various features; (5) trace desired information as neatly as possible using symbols chosen; and (6) add desired elements (e.g., title, author, date, orientation, legend, scale, source of base map).

Give students a brief demonstration of how to make their outline maps by tracing some outline information from a wall map, using a sheet of clear acetate and suitable pens, and then projecting the tracing on an overhead projector onto a screen next to the wall map. This demonstration enables students to readily see the process of information selection and generalization. This assignment, in various forms, may be used on several occasions throughout the year to review and reinforce map skills. It is a great aid for place learning, and the maps may also be used as base maps for making special purpose maps. A key to its success is getting a good quality translucent tracing paper that permits students to read the map beneath easily. The ability to make outline or special purpose maps for reports or class presentations is a skill that will serve students well in later life.

Lesson Sixteen: Making Special Purpose Maps

One of the most valuable map skills students can learn is to compile qualitative or quantitative data from non-map sources (e.g., almanacs, statistical abstracts, news media) and display these data cartographically. At the conclusion of this lesson, students should be able to locate desired data, compile data on an outline map, select a suitable symbol system, and make a finished special purpose map showing the data and including the necessary elements (e.g., title, orientation, date, author, legend, source of data).

Materials needed are an outline map of your world region, country, state or province with major political boundaries included, and a statistical abstract with a variety of quantitative data about the political subdivisions shown on the outline map. Most countries publish annual statistical abstracts. World almanacs, *World Military and Social Expenditures* (published by World Priorities, Box 25140, Washington, DC 20007), and *World Population Data Sheet* (published by the Population Reference Bureau, 1337 Connecticut Avenue, NW, Washington, DC 20036) are good, inexpensive sources for country and world regional data.

Introduce the lesson with questions such as these: Suppose you want to make a map showing where some special activity is located, or how much of something is produced or found in different countries or states, how would you go about making such a map? What steps would you follow in order to do the job most efficiently? The steps for making such a map are (1) to decide what to map (e.g., population by state, cities with professional basketball teams); (2) to find necessary data in an accurate

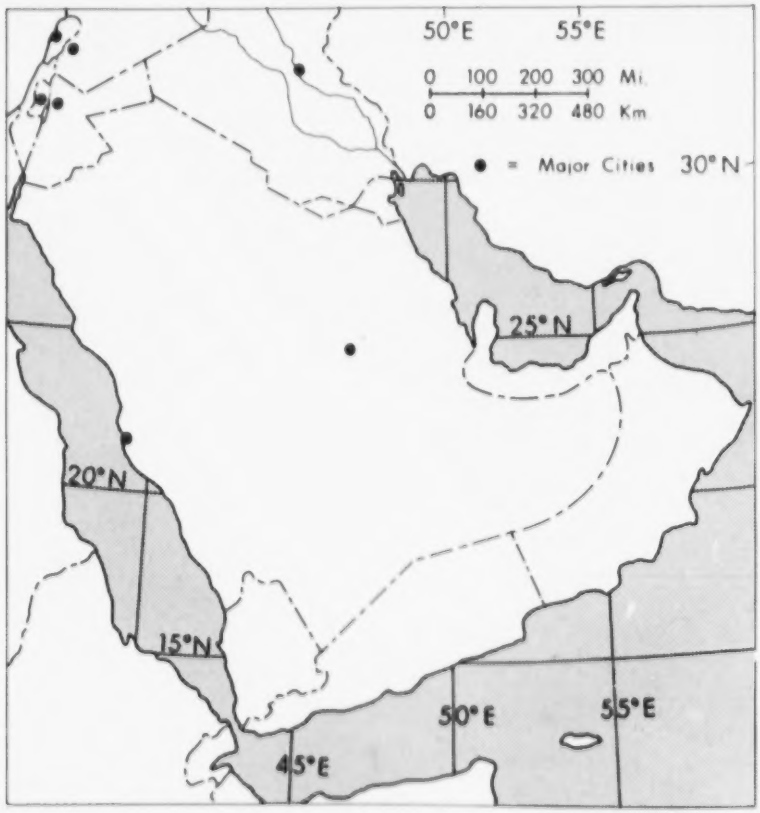

Figure 30. Outline map of the Arabian Peninsula compiled from an atlas map for student use. Source: Author.

source; (3) to find or make a suitable outline map; (4) to decide on symbols to use for displaying data on the map; (5) to plot symbols on the map; and (6) to complete the map by including the elements of title, author, date, legend, and source of data.

Show students examples of special purpose maps, which can be taken from published sources (e.g., newspapers, books, periodicals, atlases). You may also wish to show good examples of maps made by previous students. Distinguish between four major classes of special purpose maps: (1) *Qualitative distribution* maps show the location of some special activity or event (e.g., cities on the Jackson family concert tour, location of Indian reservations) (Figure 31); (2) *generalized* or *gross quantitative distribution* maps show in absolute terms (numbers, tons, bushels) how much of something is produced or consumed (Figure 32); (3) *dot distribution* maps show the distribution of absolute quantitative data in fine detail (Figure 33); and (4) *choropleth* and *isopleth* maps show areal differences of comparative ratio data (e.g., population densities, per capita or per unit area data) (Figures 34 & 35). Of the four types of special purpose maps, qualitative and generalized quantitative maps are the most easily made by students in the elementary grades.

Quantitative distribution maps require students to use multiplication and division in order to convert absolute data into proportional area or bar symbols. They must also use careful judgment in the selection of appropriately sized symbols. An attractive three dimensional map can also be made using a base map glued to a piece of styrofoam, and small dowels cut to a length equal to the correct proportion plus the thickness of the foam base. For example, if one-eighth of an inch equals 25,000 people and the base is one inch thick, then a city with a population of 170,000 would be symbolized by a dowel one and seven-eighths inches long. Once the points have been spotted and labelled on the map and the dowels cut to length (pruning shears work well), a sharp pencil or nail can be used to make an opening in the foam, and a drop of glue in the hole ensures that the dowel will stay put (Figure 36).

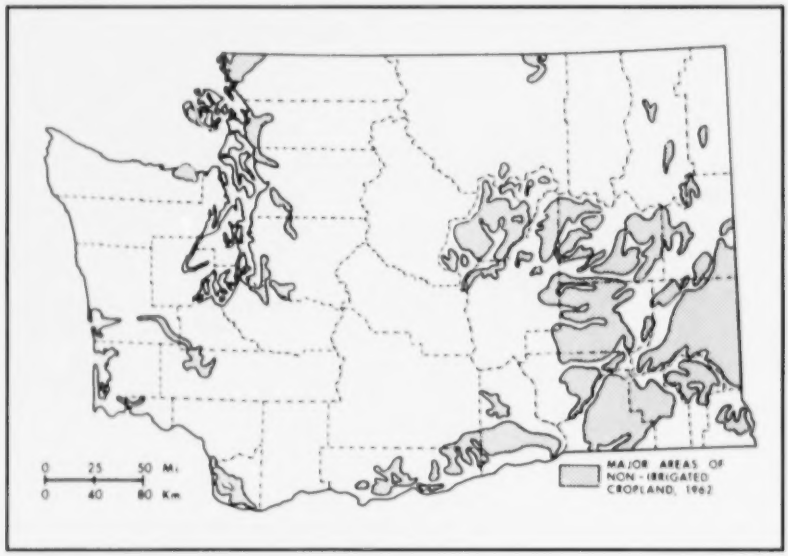

Figure 31. A qualitative distribution map: location of non-irrigated cropland in Washington State, 1962. Source: Adapted from Washington State Department of Agriculture (1963, p. 37).

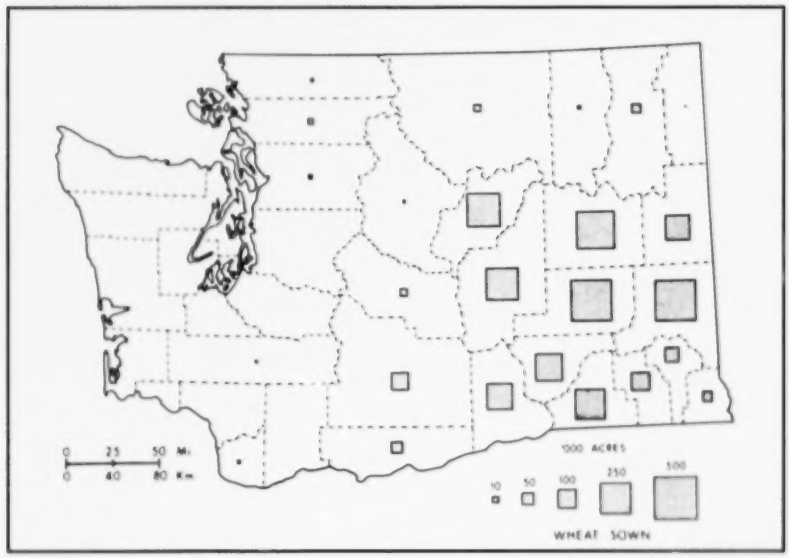

Figure 32. A generalized quantitative location map: wheat acreage planted in Washington State by county, 1983. The area of symbols has been computed to be in correct proportion with the map area. Source: Based on data from Washington Crop & Livestock Reporting Service (1984, p. 27).

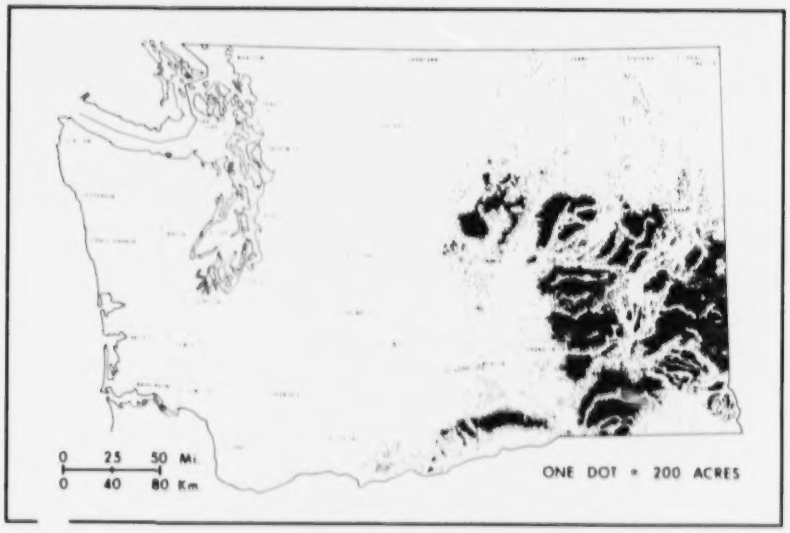

Figure 33. A detailed dot distribution map: winter wheat acreage in Washington State, 1959. Source: Washington State Department of Agriculture (1963, p. 51).

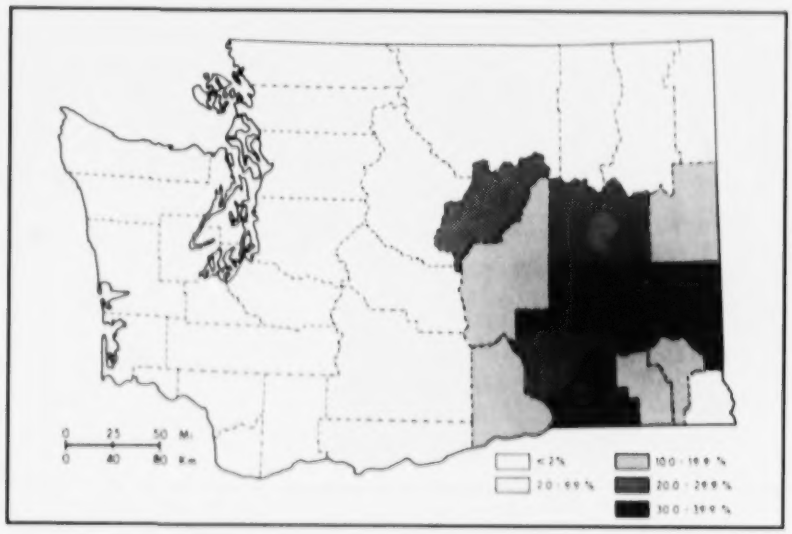

Figure 34. A choropleth map: area sown to winter wheat as a percentage of county area, Washington State, 1983. Source: Based on data from Washington Crop & Livestock Reporting Service (1984, p. 27) and Washington Office of Planning & Fiscal Management (1982, pp. 180-256).

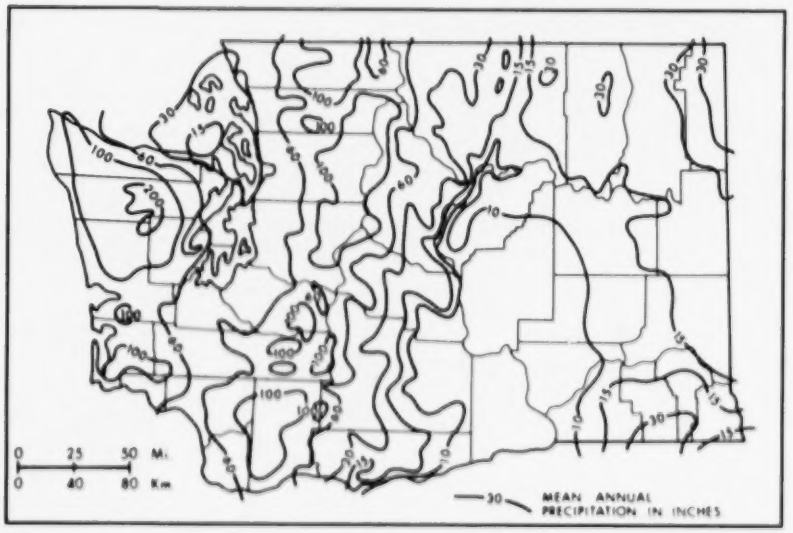

Figure 35. An isopleth map: mean annual precipitation in Washington State, 1930-1957. Source: Pacific Northwest River Basins Commission (1969, Plate A-29).

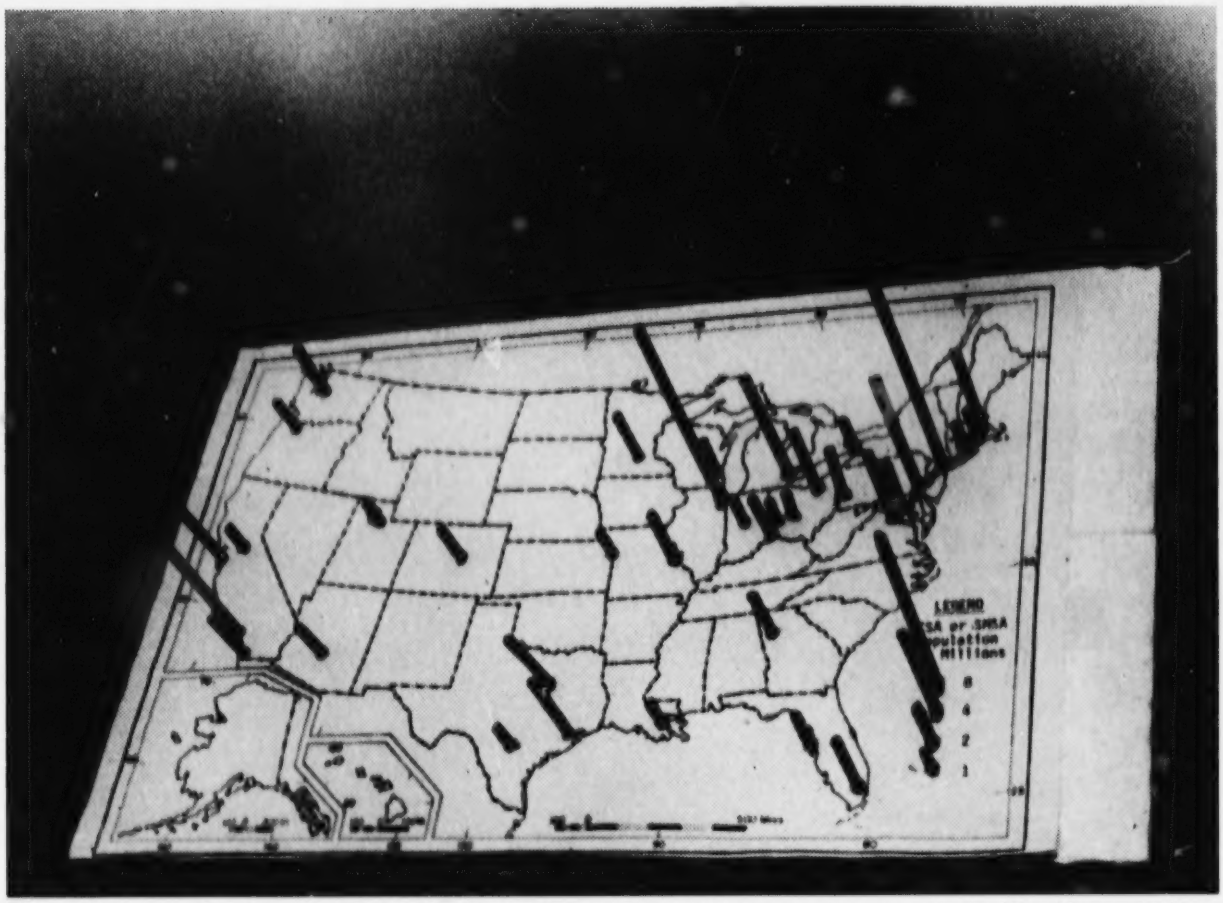

Figure 36. A "dowel" map showing the location and population of all metropolitan areas in the US with populations of more than one million. Source: Based on data from Wolfe (1981).

The assignment is for students to make either a qualitative or generalized quantitative special purpose map. It may take a convergent or divergent form. If you allow students to make a map from a data set of their own choosing, they may require the assistance of the school librarian to locate suitable data for mapping. This assignment lends itself readily to a team approach, because the various stages of map compilation and production give students practice in shared decision making and task sharing.

As in previous assignments, you may wish to demonstrate to students the processes of compilation and construction by using an overhead projector, chalkboard, or newsprint pad. Students will need several periods to complete this lesson, but it is one of special value for the enrichment or reward of students who have completed other assigned work and need an extra challenge.

Conclusion

This set of lessons emphasizes map-making rather than map-reading on the assumption that desire to make maps engenders the necessary motivation and understanding to allow students to read and use maps. The lessons provide a good introduction to the general processes of map-making and map-use, and demonstrate the great utility of maps for storing and communicating spatial information. The hidden agenda and my basic motive for writing the lessons has been to make the information available in such a way that you, the classroom teacher, will be more comfortable in working with maps, and will feel inspired to motivate your students to also freely experiment with making and using maps. The success of the lessons depends on you doing the exercises before your students do them. You must understand the pitfalls that students may encounter.[2]

Finally, remember that maps, like all messages, and messengers may often contain errors or communicate their message imperfectly. As one of my heroes once wrote when having a map rejected: "Paper is patient, it won't refuse anything; but though a river or a bridge appears on a map, it doesn't mean that you're going to find it where it is supposed to be" (Traven 1966, p. 96). Students mastering the skills of map compilation and map-making should acquire an understanding of the sources of error, be able to use maps with ease, and evaluate their content with a critical eye.

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Appendices

Appendix A

Local Sources for Aerial Photographs

The first air photographs you introduce to your students should be areas familiar to them and for which you also have large-scale map coverage. These may be most readily and inexpensively secured from local planning, soil conservation services, or other governmental offices concerned with land use. It pays dividends to make contacts in person in order to view all the maps and photographs that are available from these agencies. City hall or the county courthouse are the best places to start. Ask to see half-tone, film-positive air photographs from which they can run blueprint copies for sale. The best scale photographs for classroom use are the same scales found most useful for urban and rural planning: 1 inch to 200 feet to 1 inch to 800 feet. Local college geography or other departments concerned with natural resources (e.g., forestry, soils, geology, and urban planning) may also have collections of aerial photographs that you may look at in order to make a wise selection for the purchase of more expensive photo-prints or Landsat images. If you have a friend with a pilot's license, and access to a 35 mm camera, you can fly over your community and school area, and take slides to project on white paper. These will not be absolutely vertical and neither flying nor film are free, but this method is the cheapest means of getting color air photographs of the areas of importance to you and your students.

The principal source of US air photos is the National Cartographic Information Center of the US Geological Survey, 507 National Center, Reston, VA 22092, which publishes a free folder that provides information on aerial photographs and mosaics, where they may be obtained, and which ones are available through the US Department of Agriculture. Satellite images may be obtained from the EROS Data Center, US Geological Survey, Sioux Falls, SD 57098. More detailed information on the best sources of air photos and satellite imagery may be obtained from High School Geography Project 1970; Kroeck 1976; Nixon and McCormack 1977; Tindal 1978; Richason 1983. There are several collections of air photographs available in inexpensive paperback editions, including some paired with maps of the same area. These books are useful additions to school libraries: Richason 1972; Knowles and Stowe 1976; Gerster 1978. The National Aeronautics and Space Administration has published a magnificent collection of satellite photo-images showing all parts of the world (Short et al. 1976). Henry Castner and others have compiled an outstanding atlas for elementary schools in Ontario that includes excellent examples of air photographs paired with photomaps and maps of urban and rural areas (Castner et al. 1981).

Appendix B

Some Sources for Early Map Examples

The best places to start a search for early maps that will be of special interest to your students are at local historical museums and societies. Some larger ones may sell good reproductions of early maps of the state or region and sometimes lovely nineteenth century "bird's eye view" maps of important towns and cities (Cumming 1966; Historic Urban Plans 1984). Several histories of cartography and cartobibliographies contain good examples of maps dating back to medieval and earlier times, and some examples from non-literate cultures. A selection of these with clear black and white reproductions from which xerox copies and overhead transparencies can be made includes: Brown 1949; Cumming 1962; Bagrow 1964; Fuson 1969; Nordenskiold 1973. Lloyd Brown and Erwin Raisz have both written well-illustrated histories of cartography for junior high level readers that are worth acquiring for school libraries (Raisz 1956; Brown 1960).

Appendix C

Securing Topographic Maps of Your Local Area

The prime source of information on large- and medium-scale topographic and topical map coverage, and availability for local areas and states in the US, is the National Cartographic Information Center, Reston, VA 22092. They will send free of charge the latest index of topographic maps of your state. The indexes show the availability of topographic maps at various scales from 1:24000 (about 2⅝ inches per mile) to 1:250000 (about ¼ inch per mile) for the entire state; they also show a list of special maps and sheets published by, and available from, the US Geological Survey, and a list of stores and Geological Survey sales offices within or close to your state where a selection of the maps may be viewed and purchased.

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